**QUANTIC APPROACH TO MIND BODY INTERACTION**

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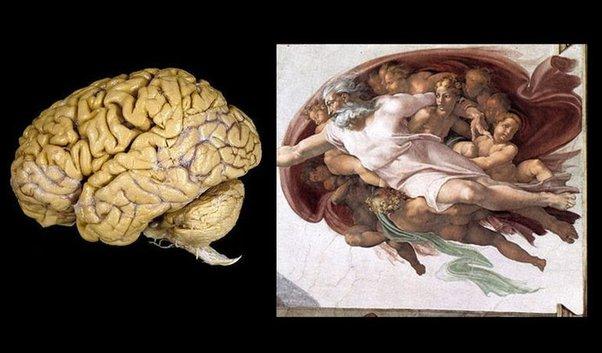
**Abstract**

The human mind–body possesses an innate ability to promote health and healing. Since there is a bidirectional influence of psychological and physiological variables on health, modern allopathic medicine, that addresses the disease in the body and disorder in the mind, should be reconceptualized for more holistic wellness. The mind-body dualism is re-evaluated in the light of different scientific findings such as energy and electromagnetic wave, information, quantum theories, and placebo effect and will focus on recent advances and future therapeutic perspectives for studying brain-body interactions in health and diseases.

**Keywords:** Mind–body medicine, Mind, Perception, quantum mechanics, nonlocality,entanglement

**Introduction**

Figure 1: The mind-body duality, was shown in the form of art in Michelangelo’s Creation of Adam, where the mind and thought are depicted by a sagittal section of the brain. Comparison of a portion of Michelangelo’s Creation of Adam with a modern anatomical drawing of the brain.



Humans have both physical and mental properties. While the physical properties include size, weight, shape, colour, motion through space and time, etc., mental properties, involve consciousness (including perceptual experience, emotional experience, and much else), intentionality (including beliefs, desires, and much else), and they are possessed by a subject or a self. Eventhough physical properties are equally observable by anyone, some – like those of an electron – are not directly observable, but they are equally available with scientific equipment and techniques. But conscious mental events are private to the subject. If the mind controls the body, the motion is qualified as dexterous, graceful, and nimble, or awkward and clumsy. If the motion is without volition, then we consider as spasms, reflexes, and stumbles. The perception from the body to the mind is called sensation . If the body control is obstructed, while the mind functions normally, we say paralyzed, dazed, numb, asleep, knocked out, deaf, and tired. (1)

While Plato believed that the true substances are not physical bodies, Aristotle did not believe in Platonic Forms and explained the union of body and soul by saying that the soul is the form of the body. He argued that the intellect must be immaterial because if it were material it could not receive all forms. Just as the eye, because of its particular physical nature, is sensitive to light but not to sound, and the ear to sound and not to light, so, if the intellect were in a physical organ it could be sensitive only to a restricted range of physical things, as it does not have a material organ, its activity must be essentially immaterial. (2,3)

**CARTESIAN DUALISM**

In the seventeen century, René Descartes suggested that the body operates like a machine and posited the mind as a non-material entity residing in the pineal gland. In order to reconcile his theory with the religious view of the day, he claimed that the mind continues to exist even beyond the physical death of the body. Cartesian dualism gradually became an ‘official doctrine’ . Descartes was a substance dualist. He held the view that mind and body are two dependent substances and thereby he is called a dualist philosopher.He believed that there were two kinds of substance: spatially extended matter and the thinking mind. His conception of the relation between mind and body was quite different from the Aristotelian tradition. For Aristotle, how matter behaves was essentially affected by the inner form and its nature was a necessary condition for the nature of the substance.

The more modern versions of dualism have their origin in Descartes’ Meditations on First Philosophy (1641) where he viewed a person as having both a physical body and a non-physical mind. He splits the brain and the mind, by two different kinds of substance: aphysical, extended substance (res extensa) and a thinking, unextended substance (res cogitans). In the “substantive dualism”, the mind, as a nonphysical entity is separate from the body. In “attributed dualism” the mind is not a separate entity, but shows two distinct properties, one psychological (thoughts, feelings, volitions); the other physical (electrical and chemical properties of the nervous system). The main uncertainty that faced Descartes and his contemporaries, was not where interaction took place, but how two different things as thought and extension could interact. The “mind” refers to the human-like features, while the “brain” “concretizes” the mind. (4)

Locke, as an empiricist, accepted that there were both material and immaterial substances, but it was impossible to see how an immaterial substance can act upon a material substance and vice versa, since for him a mind was always a substance with certain attributes (or which performs certain "operations) and he was not able to discern a modus operandi in the interaction between mind and body. (5)

**MIND-BODY PARALELISM**

According to Spinoza, while physical properties were different determinates of extended being, mental properties were different determinates of thinking. The standard view was that Spinoza’s single substance possesses two different attributes and instantiates, which bear both physical and mental properties. Whereas Descartes held that mind and body, as two distinct bodies were distinct extended substances, for Spinoza the distinct bodies were modes of one substance, considered as extended. Contrary to what Descartes thinks, his view that the connection between causes and their effects is logical, a species of entailmen and there are no causal relations between the mental and the physical world. This is the consequence of attribute dualism and Spinoza’s causal rationalism. Every mental state has a physical correlate. Mind-body parallelism is the view that mind and body , are causally and explanatorily parallel to each other and stand in causal chains that correspond point for point, or that corresponding mental and physical phenomena have corresponding causal explanations in terms of other mental and physical states.

To use Spinoza’s famous expression, mind and body “follow one and the same order and connection”. This may be because the mental and physical phenomena are identical. Mind-body parallelism therefore differs from interactionist forms of dualism in denying that the fundamental mind-body relation is a causal one. A parallelist conception of the mind-body problem focuses attention on the nature of the order and the need to coordinate between corresponding mental and physical processes and their logical explanations. Spinoza is a mind-body parallelist: he thinks that the mind stands in the same causal and explanatory relations as the body. In Spinoza’s metaphysics, minds are modes of the attribute of thought and bodies are modes of the attribute of extension. Spinoza’s mind-body parallelism is not just the claim that the mind is parallel to the body,but also incorporates the idea that the mind represents the body.

Rejecting notorious Cartesian interactionism and substance monism in response to Descartes’ substance dualism that a substance can have only one principal attribute, Spinoza argues that there is no contradiction in the idea of a single substance’s having several attributes with an identity theory, according to which the mind and the body are “one and the same thing, but expressed in two ways” saying that “The body cannot determine the mind to thinking, and the mind cannot determine the body to motion, to rest or to anything else (if there is anything else)” because he believed that it implied false views about human psychology, particularly in relation to free will and motivation. (6,7)

|  |  |  |  |
| --- | --- | --- | --- |
| A rudimentary sketch of the general structure of Spinoza’s ontology  Attributes/Substance: | Thought ––– God ––– Extension | | |
|  | | |  | | |
| Infinite Modes: | Infinite Intellect |  | Motion  Rest |
|  | | |  | | |
| Finite Modes: | A Mind |  | A Body |

**IDENTITY THEORY**

Hume drew a systematic formal distinction of conception between mental and physical systems. Every entity is in either a spatial mental system or a non-spatial physical system, and no entity is in both. By using his philosophy as an analytical tool, he showed that what can exist are only perceptions of “perishing and fleeting” existences, which cannot continue to exist from one moment to another. In ‘Of Personal Identity’, Hume presents his constructivist view of minds by writing that “what we call a mind, is nothing but a heap or collection of different perceptions, united together by certain relations, and supposed, tho’ falsely, to be endow’d with a perfect simplicity and identity.” (8,9)

Berkeley rejected all existence outside the mind as well as material substance. In his early Notebooks, he reduced the self to a collection of ‘ideas’ that constituted its contents. A crisis in the history of dualism came, with the growing popularity of mechanistic theory in science in the nineteenth century. Everything that happens should follow and be in accord with the laws of physics. There is, no scope for interference in the physical world by the mind in the way that interactionism requires. (10)

**EPIPHENOMENOLISM**

According to the mechanist, the conscious mind is an epiphenomenon ,a notion given by T. H. Huxley (1893) who called epiphenomenalism instead of dualism, where the interaction is defined in the direction from the body to the mind. Later it is modified as interactionalism, to mean that the mind and body interact in both directions and mental and physical events causally influence each other. The physical world influences my experience through my senses, and I often react behaviourally to those experiences. My thinking influences my speech and my actions. The simplest objection to interaction is that as mental properties, states or substances, being radically different kinds from each other, lack the communality necessary for interaction.

Huxley begins with physicalizing biology by defining the brain as the 'seat' of all forms of consciousness and drawing attention to the notion of a reflex action that he points out as bodily action that appears to bypass the mind. Huxley has reached what philosophers call Epiphenomenalism. An objection often made against Epiphenomenalism is a causal by-product of evolution. by natural selection. Epiphenomenalism is the view that mental events are caused by physical events in the brain, but have no effects upon any physical event. Behavior is caused by muscles that contract upon receiving neural impulses, which are generated by input from other neurons or from sense organs. Mental events will be identical with some of these neural events that will effects of mental events which will “make a difference” to our behavior through a causal contribution.

The central motivation for epiphenomenalism lies in the premise that whenever there is a sufficient cause of a physical event, there is a sufficient physical cause of that event. If a mental event is something other than a physical event, then for it to make any causal contribution of its own in the physical world would require a violation of physical law. Descartes’ interactionist model proposed that nonphysical events could cause small changes in the shape of the pineal gland. But there will be no such change of shape unless there is a physical force that causes it. If the mental and the physical events are identical, there will be no room for epiphenomenalistic questions to arise.

At the end of *hisPresidential Address,* British biologist, physiologist and philosopher Thomas Henry Huxley *to the British Association for the Advancement of Science in* Belfast,1874 articulated epiphenomenalism as “all states of consciousness in us, as in brutes, are immediately caused by molecular changes of the brain-substance. It seems to me that in men, as in brutes, there is no proof that any state of consciousness is [itself] the cause of change in the motion of the matter [brain] of the organism.” (T.H. Huxley, On the Hypothesis that Animals are Automata)

The word "epiphenomenon" is derived from two Greek roots:

* "epi" (ἐπί): meaning "above" or "upon"
* "phenomenon" (φαινόμενον): meaning "appearance" or "observable event"

**Meaning:** An epiphenomenon is a secondary phenomenon that is produced or accompanies a primary phenomenon but is considered non-essential or immaterial to the primary phenomenon. It is often used to describe a mental event or phenomenon that is thought to be a consequence of physical activity but does not have any causal influence on it. Physical objects bear spatio-temporal and causal relations to each other. Mental states are characterised by two main properties, subjectivity, otherwise known as privileged access, and intentionality and their nature of the mental are both queer and elusive. Epiphenomenalism is the doctrine that, although mental events and properties exist, they lack causal efficacy. (11)

**IDENTITY THEORY**

In his “The Principles of Psychology” and “Are We Automata?”, William James (1879), argued that mental states and events, specifically: feelings of pleasure and pain , lacked causal efficacy and called it “The Automaton Theory”, which refers nowadays more usually as “epiphenomenalism”. James characterized epiphenomenalists’ mental events as not affecting the brain activity that produces them .(12)

Smart (1959) developed the Identity theory saying that mental states are identical to their associated brain states. The identity theory of mind holds that states and processes of the mind are identical to states and processes of the brain. In the opening pages of ‘Sensations and Brain Processes’, Smart discusses four different views:

* *We are reporting an “irreducibly psychical something.”*This goes naturally with a dualist view of mental properties, on which events like having after-images are irreducibly psychical.
* *We are reporting our behavioral dispositions.*This goes naturally with a behaviorist view of sensations, on which sensations are patterns of and dispositions to perform certain behavior.
* *We are not reporting anything.*This is the view that Smart attributes to Wittgenstein. On this view, reports of sensations are more like expressions -- e.g., crying, wincing, laughing -- than they are like descriptions of happenings of some sort or other.
* *We are reporting a brain process*. This goes naturally with an identity theory of sensations and other mental events, on which they are identical with (the same thing as) brain processes. This the view that Smart wants to defend.

Smart finds each of the first three options as wanting. He rejects the idea that sensations are irreducibly psychical on grounds of parsimony, otherwise they would be ‘nomological danglers’. The next step should be to understand what that view involves. The identity theory identifies mental states and processes with brain states and processes more than identifying the mental with the physical. The identity theory’s rapid rise to ascendancy in analytic philosophy of mind during the late 1950s and early 1960s is often said to have constituted a sea change in perspective on the mind-body problem. (13-14).

**BEHAVİORISM**

Although dualism has been out of fashion in psychology since the advent of behaviourism (Watson 1913) and in philosophy since Ryle (1949), the argument is by no means over. Twentieth century British philosopher Gilbert Ryle presented a serious challenge to substance dualism with his book “The Concept of Mind” (1949), in which he argued that the positing of ‘mind’ as a substance constitutes a logical fallacy, and considered the mind as an aspect of the body’s own activities without separating from the body itself.

In contemporary philosophy of mind, he has established an important connection between mental predicates and behaviour and stapled an elusive mental event construed as a conscious “experience” onto a biological (muscular, neurophysiological) causal chain and has turned the dualism toward behavioralism. Ryle’s ideas were very influential and have ‘put the final nail in the coffin of Cartesian dualism. Ryle strongly objected to the existence of a separate substance inside or outside the physical body and his ‘category mistake’ argument, that he termed ‘Cartesian myth’ , was an effective response to Descartes's dualist view of the mind and body. To Ryle, Cartesian dualism was a conceptual illusion deriving from the misapplication of linguistic referents.

Designating Descartes‟ dualism as „official theory, he described the presumption of a separate mental substance and failure to distinguish between knowing-how and knowing-that as a ‘category mistake’ and developed his theory of logical behaviourism rejecting Descartes‟ dualistic theory of mind. Ryle’s distinction between the two types of knowledge ,‘knowing what mind is’ and ‘knowing how mind operates’ is therefore an auxiliary argument to his original criticism of substance dualism and a significant contribution to the inquiry of mind with his cognitive repertoire. He believed that the study of mind could be explained in terms of ‘know-how,’ and its inquiry should not be into causes but rather into capacities. The ‘know-how’ approach to mind allows for a more comprehensive understanding by incorporating crucial aspects of mental processes that may not be accessible via a theoretical inquiry alone and offers a dispositional account of mental concepts whereby mind is presented as an ability, tendency, liability or proneness to act or react in a certain way and not as the person’s functional competence .

Ryle recognized the role of the mind in predisposing a conscious agent to engage in certain types of behavior and defined the mental concept as an expression that sums up the person’s past history of behavior. The nature of a person's mind may be understood through actions and reactions exhibited in various circumstances. Modern cognitive science also follows the approaches of pragmatism and phenomenology in asserting that perception and cognition of the conscious subject may be understood in terms of certain patterns of behavior and experiences in determining the type of a mental state that arises from interaction with the physical environment.

As Ryle noted, investigating mind through knowing led to the mistaken assumption that there should be a certain ‘place’ where thoughts emerge. This premise caused the Cartesian dualists to posit two separate substances: the first being the location where thoughts arise and the second the thoughts themselves. Mental processes are not necessarily produced purely through theoretical or conceptual reasoning, but also entail an experiential component. This agrees with the phenomenological approach that emphasizes the embodied experience. The interaction between non-physical thoughts and physical bodies was a problem for dualism. When the mind and body are essentially distinct, the way in which they interact causally becomes puzzling and hard to understand. This is addressed by Ryle's integrated perspective, which acknowledges that mental states are really higher-order descriptions of physical processes .

Ryle observes that Descartes bifurcates a person‟s life into two halves, one is external and the other internal. All the physical things including human bodies belong to the external world while the states and processes of one‟s own mind are internal. Ryle maintains that this antithesis of outer and inner world should nbe taken as a metaphor because if the spatial existence of mind is denied then it is not possible to speak of the mind as being spatially “inside” something.

In addition to this metaphorical bifurcation of person‟s two lives there is another philosophical assumption. The official theory believes that there are two kinds of existences or states, one is physical existence and another is mental existence. Thus whatever exists must have either physical or mental status. Thus what has physical existence occupies space and time and what has mental existence is not found in space but only in time. The physical existence consists of matter where the mental existence consists of consciousness. This theory further maintains that there is no direct way to know the inner life of other persons. It is from the behavior of others that an analogy could be made inferring the occurrences of another‟s mind. The direct awareness of the workings of mind is possible by the person himself. „Willing‟ is a mental process which causes spatial movements in the physical body. Similarly, a physical change in the optic nerve has effects in mind‟s perception. The mind is reduced in a way to a set of dispositions, behavior and acts of habit and the knowledge of something is produced from practice.

Ryle also argues against the theory of emotion which is supposed by Descartes to be a sort of individual private internal experience. The emotions, which cannot be publicly observed, are considered as turbulences in the stream of consciousness. Ryle says that emotion is used to designate four different kinds of things, which are called by him as „inclinations‟, „moods‟, „agitations‟, and „feelings‟. Among these the first three are not acts or states and cannot be publicly or privately observed. But he believed that feelings are occurrences. The meaningful referent of the concept of mind should be the description of how people behave. In explaining the nature of mind, Ryle accepts the fundamental notions of the behaviouristic psychology and thus his theory is called the theory of Logical Behaviourism. He does not deny the existence of mind rather he criticizes the way in which Descartes explains it. Ryle is properly called ‘analytic’, since he has given a priori conceptual analyses for some mentalistic sentences in behavioural dispositional terms. (15)

In 1912 the behaviorists reached the conclusion that they could no longer be content to work with intangibles and unapproachables. The interest of the behaviorist in human being’s doings is to control his/her reactions as physical scientists want to control and manipulate other natural phenomena. The behavioristic psychology tries to predict and control human activity. The behaviorist claims that there is an immediate response to every effective stimulus. The two commonsense classifications of response are “external” (“overt”) and “internal” ( implicit). (16)

The doctrine of Behaviorism,, is committed to the truth of the following three sets of claims.

1. Psychology is not just the science of the inner mind but the science of behavior.
2. Behavior can be described and explained without referring to mental events or to internal psychological processes, becauzse the sources of behavior are external (in the environment), not internal (in the mind, in the head).
3. In the course of theory development in psychology, mental terms or concepts describing or explaining behavior, should be either eliminated and replaced by behavioral terms or translated or paraphrased into behavioral concepts.

Methodological behaviorism is a normative theory about the scientific conduct of psychology, that should concern with the behavior of organisms (human and nonhuman animals) and not with mental states or events or with constructing internal information processing accounts of behavior. According to methodological behaviorism, reference to mental states, such as an animal’s beliefs or desires, adds nothing to what psychology can and should understand about the sources of behavior. Mental states are private entities and do not form proper objects of empirical study.Psychological behaviorism, which is a research program within psychology, explains human and animal behavior in terms of external physical stimuli, responses, learning histories, and reinforcements for certain types of behavior.

Analytical or logical behaviorism is a theory within philosophy about the meaning or semantics of mental terms or concepts. A mental state or condition is a behavioral disposition or family of behavioral tendencies, evident in how a person behaves in one situation rather than another. To attribute a belief, for example, to someone, does not mean that he or she is in a particular internal state or conditio, instead, characterizes the person in terms of what he or she might do in particular situations or environmental interactions. Analytical behaviorism may be found in the work of Gilbert Ryle (1900–76) Each of methodological, psychological, and analytical behaviorism has historical foundations. Analytical behaviorism traces its historical roots to the philosophical movement known as Logical Positivism, that proposes that the meaning of statements used in science must be understood in terms of experimental conditions or observations that verify their truth.

This positivist doctrine is known as “verificationism” , that underpins or grounds analytical behaviorism, in psychology,where mental concepts refer to behavioral tendencies and must be translated into behavioral terms. Analytical behaviorism avoids the metaphysical position known as substance dualism which is the doctrine in which mental states are in a special, non-physical mental substance (the immaterial mind). Psychological behaviorism’s historical roots consist, in part, in the classical associationism of the British Empiricists, foremost John Locke (1632–1704) and David Hume (1711–76) and claim that intelligent behavior is the product of associative learning. As a result of associations or pairings between perceptual experiences or stimulations on one hand, and ideas or thoughts on the other, persons and animals acquire knowledge of their environment and how to act.

Associations enable creatures to discover the causal structure of the world. Association is viewed as the acquisition of knowledge about relations between events. Intelligence in behavior is a mark of such knowledge.Classical associationism relied on introspectible entities, such as perceptual experiences or stimulations as the first links in associations, and thoughts or ideas as the second links. To understand the origins of behavior, Psychological behaviorism, motivated by experimental interests, replaces references to stimulations (experiences) by stimuli (physical events in the environment), and eliminates or displaces references to thoughts or ideas in favor of responses (overt behavior, motor movement). Psychological behaviorism is associationism without appeal to inner mental events.

Radical behaviorism is concerned with the behavior of organisms, not with internal processing and understands behavior as a reflection of frequency effects among stimuli, which means that it is a form of psychological and methodological behaviorism.Logical or analytical behaviourism was analytic philosophy of mind’s first original materialist-monist solution to the mind-body problem and to reigned in various metaphysically extravagant forms of dualism and introspectionism.One defining aspiration of traditional behaviorism is that it tried to free psychology from having to theorize about how animals and persons represent (internally, in the head) their environment. This effort at freedom was important, historically, because it seemed that behavior/environment connections are a lot clearer and more manageable experimentally than internal representations.

Behaviorism generated a type of therapy, known as behavior therapy and developed behavior management techniques for autistic children and chronic schizophrenics. Behaviorism is dismissed by cognitive scientists, who have developed intricate internal information processing models of cognition and argue that the laws of psychology do not appeal only to behavioral dispositions,but the best empirical theories of behavior are the result of a complex of mental states and processes, introduced and individuated in terms of the roles they play in producing the behavior to be explained.

Logical behaviorism is a thesis in which the mental state terms or concepts and processes are equivalent in meaning to statements about behavioral dispositions. In contrast, scientific behaviorism is an empirical theory that attempts to explain the behavior of humans (and other animals) by appealing solely to behavioral dispositions, Stimulations and behavior, unlike thoughts, feelings, and other internal states can be directly and objectively observed. The early functionalist theories of Putnam can be seen as a response to the difficulties facing behaviorism as a scientific psychological theory, and as an endorsement of the new computational theories of mind. (17-19)

**FUNCTIONALISM**

Putnam (1973) suggested the term “functionalism” where mental states are thought to be realizable by multiple brain states, which are considered more abstract than their biological or mechanical realization. According to the the doctrine of functionalism in the philosophy of mind, what makes something a mental state of a particular type such as a thought, desire, pain does not depend on its internal constitution, but rather on the way it functions, or the role it plays, in the system of which it is a part. More precisely, functionalist theories determine the identity of a mental state by its causal relations to sensory stimulations. The functionalist theories belong to one of three major strains – “machine state functionalism”, “analytic functionalism”, and “psychofunctionalism”. According to machine state functionalism, the mind’ operation can be specified by a set of instructions (a “machine table” or program) having the form of a deterministic automaton. Putnam prefers probabilistic automaton where the machine enters with specific probability for the subsequent state and produce a particular output for each state and set of inputs.

Analytic functionalism, which is emerged from logical behaviorism, provides dispositional, or other “topic-neutral”, translations or analyses of the ordinary mental state terms or concepts and permits reference to certain causal and transitional relations that stimulate, behavior, and other mental states. (20)

**PSYCHOFUNCTIONALISM**

Psychofunctionalism, can be seen as straightforwardly adopting the methodology of cognitive psychology in its characterization of mental states and processes as entities defined by their role in a cognitive psychological theory. What distinguishes it from analytic functionalism is that the information used in the functional characterization of mental states and processes needn’t be restricted to what is considered common knowledge or common sense, but can include information available only by careful empirical observation and experimentation. For example, a psychofunctional theory might be able to distinguish phenomena such as depression from sadness or listlessness even though the distinctive causes and effects of these syndromes are difficult to untangle solely by consulting intuitions or appealing to common sense.

Psychofunctional theories will not include characterizations of mental states for which there is no scientific evidence, such as buyer’s regret or hysteria, even if the existence and efficacy of such states is something that common sense affirms. On the other hand, intentional states such as beliefs, thoughts, and desires ( called “propositional attitudes”) have often been thought to be easier to characterize functionally than experiential states such as pains and color experiences. Psycho-functionalism is the claim that the decision concerning the ‘correct’ functional description of a mental state is a matter of empirical hypothesis rather than conceptual analysis. In other words, they hold that whether a particular functional individuation of a given mental state is successful or not depends on empirical findings rather than on *a priori* reflection.

In the last part of the 20th century, functionalism stood as the dominant theory of mental states. Like behaviorism, functionalism takes mental states out of the realm of the “private” or subjective, and gives them status as entities open to scientific investigation. But, in contrast to behaviorism, functionalism’s characterization of mental states in terms of their roles in the production of behavior grants them the causal efficacy that common sense takes them to have. Functionalism is a theory about the nature of mental states. According to functionalism, mental states are identified by what they do rather than by what they are made of. Contrasted with behaviorism, functionalism retains the traditional idea that mental states are internal states of thinking creatures. Contrasted with identity theory, functionalism introduces the idea that mental states are multiply realized.

In contemporary theories applied to the mind, the functions in question are usually those that mediate between stimulus (and psychological) inputs and behavioral (and psychological) outputs. Hilary Putnam’s contribution was to model these functions using the contemporary idea of computing machines and programs, where the program of the machine fixes how it mediates between its inputs and standing states, on one hand, and outputs and other standing states, on the other. Modern computers demonstrate that quite complex processes can be implemented in finite devices working by basic mechanical principles.

If minds are functional devices of this sort, then one can begin to understand how physical human bodies can produce the tremendous variety of actions and reactions. The best theory, Putnam hypothesized, is that mental states are functional states. (21)

**COMPUTATIONAL FUNCTIONALISM**

Computational functionalism is the view that mental states and events – pains, beliefs, desires, thoughts and so forth – are computational states of the brain, and so are defined in terms of “computational parameters plus relations to biologically characterized inputs and outputs” .Hilary Putnam is the father of computational functionalism, a doctrine he developed in a series of papers beginning with “Minds and Machines” (1960) and culminating in “The Nature of Mental States” (1967). In recent years, however, there has been growing dissatisfaction with computational functionalism. Putnam himself , dismisses computational functionalism as a utopian enterprise. As Putnam makes clear, the mind-brain identity theory in question was in fact a more restricted identification of sensory consciousness with physical states. The non-dualist alternative, is to treat the distinctions between inside and outside, subject and object, mind and world within experience. (22)

**COMMONSENSE PSYCHOLOGY**

Commonsense Psychology refers to the implicit theories to make sense of people's behavior in terms of their beliefs, goals, plans, and emotions and anthropomorphize complex machines and computers as if they had humanlike mental lives. Common sense is the name given to all the intuitive beliefs, assumptions, and reasoning abilities that are known and accepted by everyone and help to understand and interpret the world. Common sense knowledge, which is not based on any conscious method, has emerged due to the use of the senses and the most primitive kind of experience. For these reasons, scientific and common sense knowledge have quite different characteristics.

Scientific knowledge, which is obtained using specific methods and tools , is objective, systematic, consistent, and open to criticism. It concerns more precise information about the world . However, common sense knowledge is experiential and depends on repeated personal experience. Though they share similarities, common sense knowledge, and common sense reasoning differ significantly The Gordon-Hobbs theory defines a representational area of common sense as a cluster of related terms and concepts.

Gordon-Hobbs acknowledge that “concepts in commonsense knowledge cannot be defined precisely with necessary and sufficient conditions”. In their theory, they identify a list of terms that express concepts associated with each representational area and recommend that these terms should also be explicitly formalized. In the theory of the mind-body interaction of Gordon and Hobbs, a person has both a mind and a body, connected by two channels of sensation and control.

The mind, body, sensation channel, and the control channel having a 3-valued state, either active, impaired, disabled, or inactive , in the case of body, intact, damaged, or destroyed. The stimulated body changes the mind’s perception through the channel of sensation. With an active mind, an intact body, and active control, the will is turned into an action. The first channel of interaction between the body and the mind is the sensation, where the stimulation of the body enables perception through sense organs. . Sensation, is the channel by which this sensory information is passed to the mind.

The second channel of interaction between the body and the mind is the control channel that puts the person’s will into a bodily action, by their level of control which , occurs in accordance with the person's will even if the intended result of the action fails to occur. The control channel transforms the will into an action, while the normal sensation channel translates the stimulation into beliefs in the mind. The body’s actions are the consequences of the mind’s will, by the channel of control. The mind's perception, as a consequence of the world stimulating the body, is mitigated by the channel of sensation. The body's actions are the consequences of the mind's will, mitigated by the channel of control. With an active mind, an intact body, and active control, the will yields action.

Bodily actions are initiated when a person wills them to occur. The predicate will is the relation between the person and the action when the mind executes intended action. Accordingly, the will distinguishes the intended body action from an unintended one. A special type of unintended bodily action , a reflex, where stimulation of the body is the cause. The control channel can also influence the sensation channel. A person can listen intently to a distant conversation or track a moving object with their eyes or try to ignore a pain, avert their eyes, or shut out an annoying sound. The action of "tuning in" is a body action that enables stimulation. (23-25)

**EMOTIONS**

There are close relationships between emotions (psychological processes) and bodily responses (somatic system) during the formation of mental experiences. The lived body is considered as the “body in human experience” or the “perceived body” as the projection of the body into the real world. Efforts to understand the close and complex relationship between the mind and body are not limited to philosophy and anthropology and recent studies in the field of neuroscience have showed mutual interactions between bodily responses and emotions in which physical functions trigger emotional experiences and emotional experiences lead to particular spatial patterns of sensation throughout the body.

Retrieving an emotional memory from a perceived emotional stimulus, involve perceptual ,somatovisceral and motoric reexperiencing(referred as embodiment) of the relevant emotion in one’self. There is a reciprocal relationship between the bodily expression of emotion in which how emotional information is interpreted. For example, the embodiment of anger is manifested as a muscle tension , the enervation of certain facial muscles with the rise in the blood pressure and peripheral resistance .

The sensation patterns of the subjective emotional feelings are triggered by the perception of bodily states that reflect changes in the skeletomuscular, neuroendocrine, and autonomic nervous systems. Somatosensation and embodiment play critical roles in emotional processing. The discernible sensation patterns associated with each emotion correspond with the major changes in physiological functions. All cultures have different body related expressions for emotional states. For example voluntary reproduction of facial expressions induce subjective feelings of the corresponding emotion and produce differential changes in physiological parameters such as heart rate, skin conductance, finger temperature, and muscle tension . The mental experiences are related to the emotions (psychological processes) and bodily responses (somatic system) . The lived body is considered as the “body in human experience” or the “perceived body” as the projection of the body in the real world. (26)

The belief that the mind plays an important role in physical illness goes back to the earliest days of medicine. East Asian medicine already uses a holistic approach to interpret the human body and its disorders, including emotional and psychosomatic disorders.

Efforts to understand the close and complex relationship between the mind and body are not limited to philosophy and anthropology and recent studies in the field of neuroscience have showed mutual interactions between bodily responses an functions trigger emotional experiences and emotional experiences lead to particular spatial patterns of sensation throughout the body. The complex relationship between the mind and the body relationship would not be explained only by philosophy and anthropology. The particular spatial patterns of sensation throughout the body led by the emotional experiences triggered by the physical functions are the consequence of the interaction between the bodily response and emotions .(27)

**PSYCHONEUROIMMUNOLOGY**

The pro-inflamatory cytokines produced by the innate immune cells in response to a peripheral infection provoke sickness behavior. When activation of the peripheral immune system continues unabated, during systemic infections, cancer or autoimmune diseases, the immune signalling to the brain can lead to an exacerbation of sickness and the development of symptoms of depression in vulnerable people and the prevalence of clinical depression is increased in physically ill people. Inflammation is therefore an important biological event that increases the risk of major depressive episodes, due to the traditional psychosocial factors. The behaviour of sick people changes so that they feel feverish and nauseated, ignore food and beverages, and lose interest in their physical and social environments. They tire easily and their sleep is fragmented. They feel depressed and irritable, and can experience mild cognitive disorders ranging from impaired attention to difficulties in remembering recent events.

The response to infection is characterized by endocrine, autonomic and behavioural changes. Pro-inflammatory cytokines produced at the site of infection by activated accessory immune cells not only induce symptoms of sickness, but also true major depressive disorders in physically ill patients without previous history of mental disorders. The brain–cytokine system is the conductor of the ensemble of neuronal circuits and neurotransmitters that organize physiological and pathological behaviour. High amounts of inflammatory cytokines impair mood, cognition, sleep and appetite, and contribute to the development of affective disorders.

Cytokines can cross the blood brain barrier (BBB) through leaky area by active transport. Increased permeability of the BBB activates immune or neurotoxic cytokines to cause and trigger psychopathological changes. Prolonged proinflammatory cytokine production adversely affect mental health in vulnerable individuals with symptoms of fatigue, malaise, and diminished appetite. It was thought that these symptoms were directly caused by infectious pathogens, but it is now known that proinflammatory cytokines are both sufficient and necessary to generate sickness behavior even in absence of infection or fever.

The reciprocal interaction of the immune system on the brain and behavior have taken center stage on immunologically-based diseases including infectious illnesses, autoimmune disorders, and cancer, because activated inflammatory processes affect multiple aspects of CNS (central nervous system). Brain-immune interactions are the essential component in psychiatric and medical co-morbidities. (27)

Psychoactive drugs may be used to treat some inflammatory diseases, and drugs that affect immune system, may be useful in treating some psychiatric disorders. Diseases associated with chronic inflammation significantly affect one’s mood or level of anxiety. Therefore any classification of illnesses in medical and psychiatric specialities, demarcating the mind and body, would be artificial.

It is generally accepted by both physician and patient that the mind can affect the course of illness. After the discovery of antibiotics, a new assumption arose that treatment of infectious or inflammatory disease require only the elimination of the foreign organism or agent that triggers the illness. In the rush to discover antibiotics and drugs that cure specific infections and diseases, the fact that the body's own responses can influence susceptibility to disease and its course is ignored by medical authors.

The research into infectious and inflammatory disease first led 20th-century medicine to reject the idea that the mind influences physical illness and the body’s own responses on the physical illness influencing the susceptibility to disease and its course, but new molecular and pharmacological tools have identified a network between the immune system and the brain, that allows the two systems signalling each other continuously and rapidly, along the same pathways, showing how the state of mind influences health.

The brain and the immune system continuously signaling each other, along the same pathways, show how the state of mind influences health. Chemicals produced by immune cells signal the brain which in turn sends chemical signals to restrain the immune system affecting also behavior and response to stress. Disruption of this communication network, whether inherited or through drugs, toxic substances or surgery, provokes and exacerbates the infectious, inflammatory, and autoimmune diseases and related mood disorders. The state of the mind influences the resistance or recovery from infectious or inflammatory diseases.

A physiological event highly stressful to one individual can infuence much less another, depending on each person’s genetic tendency to hormonal reactivity and his/her previous experience. The degree to which stress can precipitate or exacerbate the disease not only depends on the intensity and duration of the stressful stimulus but also on the person’s learned perception of the event as stressful and on the set point of the stress system.

Psychological stress can influence and affect the individual’s susceptibility to infectious diseases. The relationship between psychosocial stressors and disease is affected by the nature, number, and persistence of the psychosocial stressors as well as by the individual’s biological vulnerability (i.e., genetics, constitutional factors), psychosocial resources, and learned patterns of coping.

Psychosocial interventions have been proven useful for treating stress-related disorders. If a standard dose of common coldvirus (rhinovirus) is given to volunteer individuals, who are simultaneously exposed to stress, they show more viral particles and produce more mucus than nonstressed individuals. Vaccinated people during periods of stress, develop less antibody protection. Chronic stress also prolongs wound healing .

The regulation of the immune system by the neurohormonal stress system provides a biological basis to understand how stress affects the disease. Thus, stress hormones released from the brain cortiisol from the adrenal glands, and nerve chemicals released from nerve endings, all modify the immune cells) fight against infectious agents and foreign molecules. There is evidence that stress affects human immune responses to viruses and bacteria.

If volunteer individuals, to whom a standard dose of the common cold virus (rhinovirus) is given, are simultaneously exposed to stress, they show more viral particles and produce more mucus than nonstressed individuals. People who are vaccinated during periods of stress, develop less antibody protection. Chronic stress also prolongs wound healing. New research shows that at physiological concentrations and under certain conditions the stress hormone cortisol not only is immunosuppressive but also may enhance certain aspects of immune function.

Furthermore, each part of the stress response — the brain-hormonal, the nerve and the adrenal gland — is regulated independently, depending on the nature of the stressful stimulus. This specific nature of the stress response explains how different kinds and patterns of stress affect illness differently. Therefore, whereas chronic stress is generally immunosuppressive, acute stress can enhance cell-mediated immunity and exacerbate contact dermatitis types of allergic skin reactions.

Animal studies show that social stress and physical stress have different effects on infection with different viruses, such as herpes and influenza virus and on the course and severity of viral illness, bacterial disease and septic shock. Stress in mice worsens the severity of influenza infection through both the HPA axis and the sympathetic nervous system.

So, the neuroendocrine mechanisms, that play a similar role in infections with other viruses, including HIV, provide a mechanism for understanding clinical observations that stress may exacerbate the course of AIDS. It has been shown that an intact HPA axis protects rats against the lethal septic effects of salmonella bacteria. Finally, new understanding of interactions of the immune and stress responses can explain the classic psychological conditioning of animals influencing their immune responses.

Stress is not only personal but is perceived through the prism of social interactions. These interactions can alter immune responses and affect the hormonal responses by either adding or lessening psychological stress. Thus, the social-psychological stresses can affect our susceptibility to inflammatory and infectious diseases as well as the course of these and other diseases. For instance, in humans, loneliness is associated with a "threat," or adrenaline like pattern of activation of the stress response, whereas exercising is associated with a "challenge" pattern of high blood flow and cardiac output. Studies have shown that people exposed to chronic social stresses for more than two months have increased susceptibility to the common cold and and the immune responses of long-term caregivers, such as spouses of Alzheimer's patients, become blunted.

Immune responses during marital discord are also blunted in the spouse (usually the wife) who experiences the greatest amount of stress and feelings of helplessness. In such a scenario, studies have found that the levels of stress hormones are elevated in the affected spouse(. On the other hand, a positive supportive environment of extensive social networks or group psychotherapy can enhance immune response and resistance to disease — even cancer. For example , women with breast cancer, for instance, who receive strong, positive social support during their illness have significantly longer life spans than women without such support.

For centuries, taking the cure at a mountain sanatorium or a hot-springs spa was the only available treatment for many chronic diseases. New understanding of the communication between the brain and immune system provides a physiological explanation of why such cures sometimes worked. Disruption of this communication network leads to an increase in susceptibility to disease and can worsen the course of the illness. Restoration of this communication system, whether through pharmacological agents or the relaxing effects of a spa, can be the first step on the road to recovery.

A corollary of these findings is that psychoactive drugs may be used to treat some inflammatory diseases, and drugs that affect the immune system may be useful in treating some psychiatric disorders. There is growing evidence that our view of ourselves and others, our style of handling stresses, and our genetic makeup can affect the immune system. Similarly, there is good evidence that diseases associated with chronic inflammation significantly affect one's mood or level of anxiety. Finally, these findings suggest that classification of illnesses into medical and psychiatric specialties, and the boundaries that have demarcated mind and body, are artificial.

The internal physical components are also part of brain environment, as well as the external environment located outside physical body. The brain can be aware of the internal (interoception) and external (exteroception) environment. Eventhough interoception and exteroception produce physiological changes without awareness, humans can become aware of their internal states such as anxiety or stress. Interoception is an awareness to control over internal organs through biofeedback or mind–body practices.

Immune responses during marital discord also blunted the immune responses in the spouse who experiences great amount of stress and feelings of helplessnes. Compared with other social relationships, marital relationships tend to have greater effect on an individual’s emotional and physical well-being. Although marriage is typically considered to be beneficial or protective, marital conflict can function both as an acute stressor (e.g., a solitary argument) and a chronic stressor (e.g., daily arguments for years).For some individuals, the marital relationship can be chronically stressful not because of conflict or hostility but because of the health state of the partner. Individuals who are the caring partner for spouses with Alzheimer’s and other forms of dementia experience and live chronic stress, that causes depressive symptoms and mood disorders even after the death of their spouse.

A positive supportive environment of extensive social networks or group psychotherapy can enhance immune response and resistance to disease— even cancer. For example ,women with breast cancer, who receive strong, positive social support during their illness significantly gain longer life spans than women without such support. Socially isolated women have elevated risk and higher rate of mortality after the diagnosis of breast cancer, because of the lack of access to specifically beneficial caregiving from friends, relatives, and adult children. Social support has three dimensions: emotional, informational, and instrumental support . Emotional support includes the demonstration of empathy, reassurance, love, and caring. Informational support refers to assistance with both seeking and understanding medical information. Instrumental support has been operationalized as tangible aid, and assistance in problem solving tasks for medical decision-making.

The main cause of an illness, the most important factor, why a person becomes ill, lies in the brain. Stress, pain and pleasure play a critical role in wellness, contributing significantly to the risk of disease. If a stressed person feels good, he/she will have fewer ill effects. People seeming calm outside but turmoil inside, will have disorders like migraine, irritable bowel syndrome, rheumatoid arthritis, or multiple sclerosis.

The immune system was once considered a self-regulating, autonomous agency of defense, critical in defending the organism against the invasion of foreign material and was independent of the nervous system. Research, has revealed that immunoregulatory processes are in reality influenced by the brain and, conversely, that neural and endocrine functions and behavior are influenced by the immune system. Psychoneuroimmunology is the study of the interactions among behavior, neural and endocrine function, and immune system processes.

Psychopharmacology acknowledges that drug effects depend on the state of the organism into which they are introduced. Neuroendocrinology accepts that endocrine function can only be understood in the context of its interactions with the nervous system. Psychoneuroendocrinology acknowledges that the feedback and feedforward pathways between these systems influence and are influenced by behavior. Psychoneuroimmunology, is one of the newest of the hybrid disciplines necessitated, by the need to understand better immunoregulatory processes.The evidence that changes in endocrine, autonomic and neural activity accompany immune responses supported the suggestion that the immune system acts as a a receptor sensorial organ.

Psychoneuroimmunology refers, most simply, to the study of the interactions among behavioral, neural and endocrine (or neuroendocrine), and immunological processes of adaptation. Its central premise is that homeostasis is an integrated process involving interactions among the nervous, endocrine and immune “systems.” The CNS can sense the behavior of the peripheral immune system in its recognition and response to immunogenic stimuli, then products of activated immune cells may influence neuroendocrine function. Using anatomical, neurochemical, receptor-binding, and in vitro and in vivo immunological techniques, neurobiologists have generated the evidence that sympathetic noradrenergic nerve fibers signal cells of the immune system are capable of evoking major changes in their responsiveness.

The connections between the brain and the immune system have been shown to be the major route for behavioral and for central cytokine influences on immune function. Two major pathways through which the brain and the immune system communicate: the neuroendocrine humoral outflow via the pituitary-derived neuroendocrine activity, and the autonomic nervous system (ANS) via direct neural influences. Both pathways generate chemical signals that are recognized by receptors on the surface of lymphocytes and other immune cells, and the activation or interruption of these signals influence immunologic reactivity.

Within this internal milieu , the neuroendocrine environment is sensitive to the individual’s perception and adaptive responses to events occurring in the external world. Activated lymphocytes produce neuropeptides and hormones that are perceived by the nervous system as reflected in further changes in hypothalamic, autonomic, and endocrine responses and by changes in behavior. Cytokines, messenger molecules released by activated immune cells, regulate cellular interactions within the immune system but also influence and are influenced by the hypothalamic–pituitary–adrenal axis .

The behavioral effects of cytokines, particularly with respect to sickness behavior and cognitive functions has become a major focus of current research in psychoneuroimmunology and bidirectional communication between the brain and the immune system. Pavlovian conditioning or stressful life experiences are capable of influencing immune function and the development and/or progression of immunologically mediated disease processes . The existence of these bidirectional pathways between the brain and the immune system reinforces the hypothesis that immune changes could constitute an important mechanism through which psychosocial factors influence health and disease.

Depression, for example, is a risk factor for disease and depressed patients show a decline in both enumerative and functional measures of immunity . One of the channels of communication between the neuroendocrine and immune systems is achieved through the receptors that exist on immune cells. The activation of the immune system is accompanied by changes in hypothalamic, autonomic, and endocrine processes, and by changes in behavior. For example, cytokines influence activation of the hypothalamic-pituitary-adrenal (HPA) axis — and, in turn, are influenced by glucocorticoid secretion.

The potential interaction of neuroendocrine and immune processes is further magnified by the fact that cells of the immune system activated by immunogenic stimuli are capable of producing a variety of neuropeptides. Thus, the exchange of information between the brain and the immune system is bidirectional.A variety of psychosocial events interpreted as being stressful to the organism are capable of influencing a variety of immune responses.

Different “stressors” have different effects on some constant outcome measure and that the same “stressor” can have different effects on different outcome measures. The direction, magnitude and duration of stress induced alterations of immunity are influenced by:

(a) the quality and quantity of stressful stimulation;

(b) the capacity of the individual to cope effectively with stressful events;

(c) the quality and quantity of immunogenic stimulation;

(d) the temporal relationship between stressful stimulation and immunogenic stimulation;

(e) sampling times and the particular aspect of immune function (or compartment) chosen for measurement;

(f) the experiential history of the individual and the existing social and environmental conditions upon which stressful and immunogenic stimulation are superimposed;

(g) a variety of host factors such as species, strain, age, sex, and nutritional state; and

(h) interactions among these several variables.

Prospective as well as retrospective studies in animals and humans have shown that, depending on interactions among the qualitative and quantitative nature of the environmental demands and the pathophysiologic process, the experimental procedures, and a variety of host factors, stressful experiences can alter the host’s defense mechanisms thereby altering susceptibility to bacterial and viral infections, modifying the neuroinvasiveness of normally non-neurovirulent strains of virus, or allowing an inconsequential exposure to a pathogen to develop into clinical disease.

The behavioral and emotional states that attend the perception of and the effort to adapt to environmental circumstances are accompanied by complex patterns of neuroendocrine changes. The neural and endocrine patterns associated with behavioral and emotional states are capable of modulating immune functions lends credence to the hypothesis that changes in immune function constitute an important mediator of the pathophysiological effects of stressful life experiences. The immune system is a complex system that works to recognize and eliminate foreign antigens – any protein, carbohydrate, lipid, deoxyribonucleic acid, or small organic molecule that can produce an immune response – from the body, and is divided into two subdivisions: the innate immune system and the adaptive immune system.

People exposed to chronic social stresses showed increased susceptibility to common cold, and the prevalence of depression is higher in patients with coronary artery disease (CAD). Depressed CAD patients have 84% greater risk of cardiac death compared to nondepressed CAD patients. Interstitial cystitis has been shown to be stress related disease with significantly elevated norepinephrine level in urine. Positive supportive environment of extensive social networks or group psychotherapy can improve immune response and resistance to disease—even to cancer and protect against premature mortality, prevent illness, and assist prompt recovery from illness. Medicine should adopt a biopsychosocial approach rather than an exclusively biologic model of health . If the mind controls the body, the motion is qualified as graceful or awkward. If the motion is without volition, it is considered as spasms and reflexes. The perception from the body to the mind is called sensation . If the body control is obstructed, while the mind functions normally, it is defıned as paralyzed and numbed.

A special category of sensorial capacity of the mind should be attributed to the detection of the near-death (NDEs) and religious and mystic (RMEs) experiences, besides other extra-sensorial phenomena like premonition, generated by the mind power. It was possible to detect such experiences during the clinically proved cessation of the brain activities, same in both normal and blind people. This relation shows that each individual is a distinct entity, not only as the matter structure is concerned, but also from informational point of view, according to the personal features inherited from the parents and the habits acquired during the life.

In theories of embodied cognition, the concept of reenactment and related concepts such as simulation, resonance, and emulation are widely accepted using knowledge—as in recalling memories, drawing inferences, and making plans, called “embodied” because an admittedly incomplete but cognitively useful reexperience is produced in the originally implicated sensory-motor systems, as if the individual were there in the very situation, the very emotional state, or with the very object of thought .The embodiment of anger involve tension in muscles used to strike, the enervation of certain facial muscles to form a scowl, and even the rise in diastolic blood pressure and in peripheral resistance.

The orbicularis oculi and zygomaticus are activated to produce a smile, the corrugator is activated during frowning in anger, and the levator is used to produce the grimace of disgust. Models of emotional processing assume that subjective emotional feelings are triggered by the perception of emotion-related bodily states that reflect changes in the skeletomuscular, neuroendocrine, and autonomic nervous systems. Emotional feelings are associated with discrete overlapping maps of bodily sensations, which could be at the core of the emotional experience assuming that somatosensation and embodiment play critical roles in emotional processing. The discernible sensation patterns associated with each emotion correspond well with the major changes in physiological functions associated with different emotions .

All cultures have body-related expressions for describing emotional states. Voluntary reproduction of physiological states associated with emotions, such as breathing patterns or facial expressions , induces subjective feelings of the corresponding emotion. Similarly, voluntary production of facial expressions of emotions produces differential changes in physiological parameters such as heart rate, skin conductance, finger temperature, and muscle tension, depending on the generated expression.

Bodily topography of basic (Upper) and nonbasic (Lower) emotions associated with words. Western medicine characterizes emotional disorders using “neural” language while East Asian medicine uses “somatic” language. There are close relationships between emotions (psychological processes) and bodily responses (somatic system)during the formation of mental experiences. The lived body is considered as the “body in human experience” or the “perceived body” as the projection of the body into the real world. The belief that the mind plays an important role in physical illness goes back to the earliest days of medicine. (28-33)

Psychoneuroimmunology (PNI) is a modern psychosomatic research field that can be seen as an empirical realization of the biopsychosocial model. PNI investigates the complex interplay between psychological factors and the nervous, endocrine, and immune systems and how it unfolds over the individual’s entire lifespan.One focus of PNI is the prenatal lifespan. Via the placenta and umbilical chord, the fetus is directly connected to the maternal organism (“feto-maternal interface”) and presents an immunological challenge to it. To ensure a healthy pregnancy, the mother’s immune system continuously adapts to the developing fetus.From a prenatal PNI perspective.

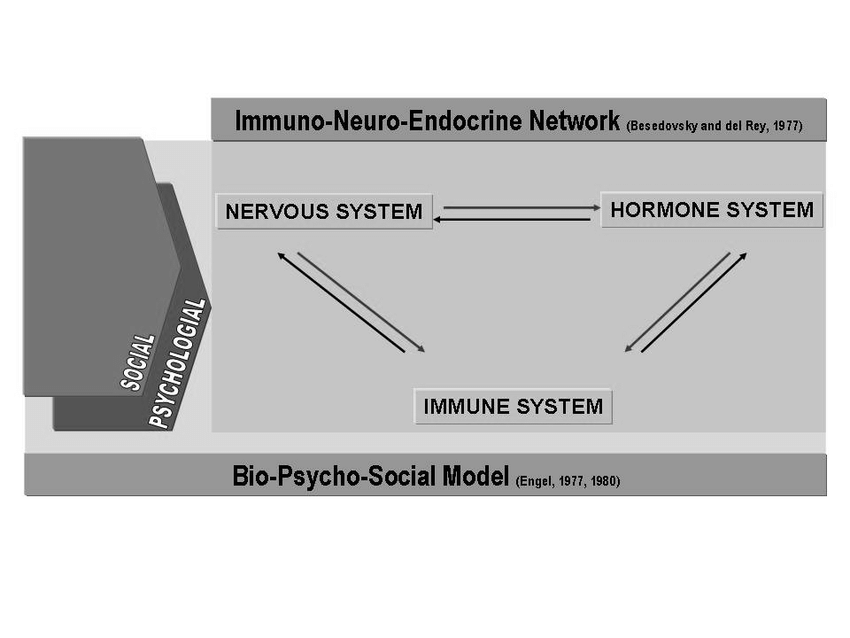
The mother may experience stress during pregnancy, either due to anxiety, depression, relationship conflicts, natural disaster, or other socially induced stressors (e.g., low socioeconomic status (SES), racial discrimination), at the neuroendocrine and immunological level..Research demonstrates that lasting and/or massive stressors in pregnancy trigger changes in both the maternal and fetal stress system (i.e., increased cortisol, corticotropin-releasing hormone (CRH), and pro-inflammatory cytokines) and can produce negative outcomes such as premature birth and low birth weight. Prenatal stress leaves epigenetic traces (e.g., NR3C1 methylation) in the child. Through long-term dysregulations of the stress and immune system, favor the postnatal development of various diseases, such as allergies and autoimmune diseases. The prenatal lifespan represents an important time window during which primary preventive measures have great potential to prevent long-term disease and promote biopsychosocial health. (34)

The systematic perspective of the biopsychosocial model assumes that natüre is a hierarchically arranged continuum, with higher order entities (e.g. society, family and organism) being superordinate to downstream (e.g. tissues, cells and genes). Within this hiearchy of biological, psychological and social systems, complex dynamic interdependencies exist –e.g. top-down/bottom-up regulatory feedback circuits-that shape human experience and can be responsible for an individual’s health and disease.

From a biosemiotic perspective , living systems such as human beings are essentially driven by sign relations and their signification in life processes. The personal meaning of a stressor is determined by both the context of the incident and its individual interpreting. The interpretention process is informed by th eperson’s current and past experience. In terms of meaning complexity, helath and disease are dependent on subjective factors. The immune system is a complex dynamic multiscale system consisting of molecular (e.g., genes, proteins), cellular, and organismal networks that act in an organized manner to foster effective functioning. The immune activity does not work independently from other internal and external systems but rather in a complex supersystem comprising social, psychological, neurological, endocrinological, and immunological entities: the socio-psycho-neuro-endocrino-immunological network.

In regard to the connection between psychosocial and immune factors, evidence from psychoneuroimmunology (PNI) shows that psychosocial interventions can modulate immune system activity . Stress-related brain mechanisms play an important role as a quasi-causal link between cognition, emotion and behavior at the psychological level and the dynamics of the immune system. Synchronization may result from intersystemic connections or from external pacemakers, whereas coupling implies direct effects of one system on the other. The immune dynamics mirror the mental (psychosocial) experiences of the subject, or play the role of a pacemaker. (35).

Early-life adversity increases the risk of a multitude of psychological, neurological and physiological problems in adulthood, including mood disorders, cognitive deficits, cardiovascular disease, cerebrovascular infarction and cancer. Adversity at an early age has the greatest impact on the individual’s development in the perinatal, adolescent and puberty phases, when the developing brain is particularly vulnerable to the programming effects of stress . During these critical phases, acute or chronic stress can trigger long-lasting or even permanent changes in the metabolism, central nervous system and immune system of young individuals . (36)

Fig.2 Immuno-Neuro-Endocrine Network and Bio-Psycho-Social Model. (37)**MIND-BODY THERAPIES**

The earliest recordings of human existence document that every society has been besieged by various maladies. Despite varying belief systems, the common goal has always been to restore the body to a state of wholeness. Medical models from ancient Egypt, Babylon, and Greece all incorporated treatment of the body as well as the mind. Likewise, both traditional Chinese medicine and Indian ayurvedic medicine contain elements that allow for the treatment of both. Central to these systems is the belief that interactions between the mind and body can bring about disease and affect health and healing. This is in contrast to modern Western medicine (MWM), which traditionally has focused on the body, evidence, and drug therapy (38).

**BIOFEEDBACK**

In 1961, American psychologist Razran first proposed the concept of biofeedback, suggesting that people can use physiological instruments to observe their physiological changes and learn to control themselves to avoid harmful stimuli. Since then, biofeedback has become an important research topic. Originally explored by Neal Miller, biofeedback (BF) is a process that enables an individual to learn how to change physiologic activity for the purposes of improving health and performance. Validated instruments measure physiologic ac tivity such as brainwaves, heart function, breath ing, muscle activity, and skin temperature. These instruments then accurately provide feedback to the user. The presentation of this information, often in conjunction with changes in thinking, emotions, and behavior, supports desired physiologic changes. Over time, these changes can persist without use of an instrument .

Biofeedback is a mind–body technique and a self-management tool in which participants get aware about their unhealthy mental patterns and habits, and learn to improve their health by controlling bodily functions (e.g., breathing rate, heart rate, blood pressure). During biofeedback treatments, participants are connected to electrical sensors, which measure bodily functions. Results are displayed on a monitor, and this feedback allows them to make subtle changes, such as relaxing particular muscles, to achieve desired results. Tones or sounds may be used to let participants know when they have achieved a certain goal or state. Biofeedback can be used as a self-management tool to treat a variety of mental health issues, including anxiety or stress as well as asthma , heart problems , pain , irritable bowel syndrome, and high blood pressure .

Biofeedback is an acquisition technique of self-regulation ability of an autonomic function, through a series of training aided by an additional outer feedback pathway. In biofeedback, internal autonomic events such as heart rate, blood pressure, or muscle tension are electronically amplified, by using electronic instruments to accurately measure, process, and “feed back” information about the body, an individual is able to learn and develop control over these internal physiological events. Internal responses thought to be involuntary have been found to be affected by consequences (i.e., operant learning) and subject to  voluntary control as well. Research has demonstrated that through operant learning, humans can gain volitional control over different internal physiological functions with consequences delivered via biofeedback

Biofeedback is a mind–body technique in which participants learn to cultivate awareness about their unhealthy mental patterns and habits, and improve their health by controlling bodily functions (e.g., breathing rate, heart rate,blood pressure). Biofeedback mechanisms, proper selection of modalities, and strategies should be combined for effective integration into treatment plans. During biofeedback treatments, participants measure bodily functions, using biomechanical techniques with simple inertial or advanced video motion sensors to assess body activity and movement.  The process begins by using noninvasive equipment connected to electrical sensors to measure a selected physical parameter, which is then displayed directly on a monitor or converted into a visual, auditory, or tactile feedback signal, which is controlled by the patient’s practice through consciously adjusting the physical parameter.

This feedback allows to make subtle changes, such as relaxing particular muscles, to achieve desired results.Tones or sounds may be used to let participants know when they have achieved a certain goal or state. Since biofeedback provides an additional form of feedback beyond the body’s intrinsic sensory system, it is known as augmented or extrinsic feedback. A variety of modalities serve to measure physiological activity such as muscle activity, (measured by electromyography), cardiac activity (measured by heart rate and heart rate variability), breathing activity (measured by respiratory rate and depth), and electrodermal activity (measured by skin conductance).

Biofeedback is a versatile technique to be used as a self management tool to treat a variety of mental health issues, including anxiety or stress as well as asthma , heart problems , pain ,irritable bowel syndrome, and high blood pressure to enhance sensory feedback and , enables individuals to gain control over typically involuntary physiological functions for symptom management as part of physical therapy, neuromuscular rehabilitation, and stress management in such cases as chronic pain, anxiety, urinary or fecal incontinence, and motor dysfunctioni

Biofeedback has been particularly effective in managing neuromuscular disorders, as part of physical therapy programs for individuals with motor weakness or dysfunction following a stroke, orthopedic surgery, or due to other neuromuscular conditions . These techniques target the overactive sympathetic response and help coordinate muscle activity in the gastrointestinal and genitourinary tracts.

Biofeedback has been shown to provide significant pain relief and improve quality of life and reduce disability for various pelvic pain syndromes, including anorectal disorders, chronic prostatitis, and pelvic pain in men, women, and children.  Integrating biofeedback with virtual reality, gaming, music, and relaxation techniques can effectively reduce anxiety in children, students, and patients with conditions such as Parkinson disease. Real-time feedback and positive reinforcement from wearable device-based biofeedback rehabilitation can enhance dynamic balance and gait in patients with neurological disorders, including Parkinson disease and post-stroke. Biofeedback may reduce the time to fall asleep and the number of awakenings.

Biofeedback training using EMG biofeedback has been proven effective in reducing both anxiety and voluntary muscle tension, which often accompany one another, at rest and prior to competition . Any amount of residual muscle tension slows reaction time and the kinetic chain (the process whereby energy travels from spinal cord to feet or hands). EMG biofeedback has shown benefits in improving quadriceps strength and knee extension and better balance Among biofeedback types, pressure biofeedback has shown more significant benefits for intermediate-term disability compared to EMG biofeedback.

Clinicians can use biofeedback techniques to manage overall physiological responses or focus on specific muscle movements. Commonly targeted muscle groups include those in the upper and lower limbs and the muscles involved in gait. Muscles controlled by the autonomic nervous system, such as those involved in digestion, defecation, and urination, are also frequently selected. For urinary incontinence, biofeedback targets the pelvic floor muscles, while for fecal incontinence, the focus is on the external anal sphincter. Biofeedback is also utilized for nonmusculoskeletal purposes, including reducing anxiety and stress. Additionally, it has been applied to regulate vascular function and decrease vasoconstriction.

<https://www.ncbi.nlm.nih.gov/books/NBK553075/> **Indications**

Clinicians can incorporate biofeedback techniques into the overall treatment plan for various conditions. This technique is commonly used to manage stress and anxiety, whether as a primary illness or secondary to another cause. Specific evidence supports the use of biofeedback for specific ailments, including the following conditions:

* Constipation
* Fecal incontinence
* Urinary incontinence
* Chronic pain, including chronic low back pain, chronic pelvic pain, and other pain syndromes
* Chronic insomnia
* Migraine headaches
* Chronic fatigue
* Fibromyalgia
* Epilepsy
* Motion sickness
* Depression
* Anxiety
* Raynaud phenomenon

<https://www.ncbi.nlm.nih.gov/books/NBK553075/>**Contraindications**

Biofeedback techniques offer a safe and well-tolerated procedure free of adverse effects with no absolute contraindications and is suitable for individuals of all ages to relieve symptoms and enhance quality of life . The technique relies on active patient participation, making it unsuitable for individuals unable to comprehend and follow commands or for those with complete paralysis. Additionally, biofeedback is not recommended as the sole treatment for severe hypertension and should be used with caution in patients with acute psychiatric conditions. Biofeedback techniques are categorized into 2 main types—physiological and biomechanical—based on the actions they target. Each approach utilizes specialized equipment to measure sensory parameters, convert them into feedback, and present the results to the patient.

* Physiological biofeedback uses electromyography to measure muscle activity. Autonomic functions can be monitored through heart rate, respiratory rate and depth, and electrodermal activity.
* Biomechanical biofeedback focuses on parameters related to movement and spatial orientation. These are measured using devices such as inertial motion detectors (eg, accelerometers or gyroscopes), force plate sensors, and real-time ultrasound.

The sensor data is processed and converted into feedback, which can be visual (eg, changing graphics or patterns), auditory (eg, varying tones or music volume), or haptic (eg, vibrations from a wearable device). Virtual reality leverages wearable motion detector sensors, advanced processing, and display technology to create interactive games incorporating rehabilitation techniques. This technology enhances patient engagement, boosts motivation, and improves overall outcomes, especially in younger populations. By empowering patients to take control of their condition, these methods play a vital role in promoting self-efficacy and overall well-being. With sufficient training, patients can achieve lasting changes without continued reliance on biofeedback instruments.

Biofeedback may reduce the need for medications, helping to minimize the risks associated with polypharmacy and limiting the potential adverse effects of other treatments.  Biofeedback techniques are most effective when integrated into a comprehensive rehabilitation plan, combined with cognitive-behavioral therapy, physical therapy, or other relaxation techniques. With the advent of biofeedback, certain previously existing distinctions between the voluntary and involuntary nervous system and between conscious and unconscious processes are being eroded. Conscious control of the autonomic nervous system (once conceptualized to be unconscious and involuntary) is as possible as conscious control of the muscular system is. Biofeedback is the process of using electronic instruments to gain awareness of many physiological functions of one's body with the intention to control these functions to improve one's health.

Although this basic concept of BF training was probably first formulated long ago by yogis learning to regulate the basal body metabolism rate, it has been developed using modern electronic technology. Exceedingly small electrophysiological activity is detected and monitored from the surface of the skin using electrodes, and information is presented (feedback), visually and/or auditorily, to show what is happening to the patient’s bodily functions that are normally too subtle to be sensed and unavailable to awareness. Control of a wide variety of physiological parameters—such as heart behavior, temperature, brain-wave activity, blood pressure, and muscle tension—using BF methodology has been demonstrated and seems limited only by the availability of opportunity to monitor the level of function in a physiological system consciously, by the possibility of providing continuous feedback. Biofeedback is a medical treatment in which physiologic markers like heart rate, breathing rate, EMG, EEG, or electrodermal ac tivity are measured and displayed back to the patient. The patient can then attempt to modulate physiology to achieve a certain feedback goal such as slowing heart or breath rate, or relaxing certain muscles. The desired feedback goal is based on the specific condition being treated.

Research has explored brain activity biofeedback with real-time functional resonance magnetic imaging (fMRI) during pain stimuli, and has found that subjects could learn to control activation in the rostral anterior cingulate cortex (rACC) and found a deliberate increase or decrease in fMRI signal in the rACC, corresponding to a change in the perception of a thermal pain stimulus. Furthermore, chronic pain patients could be trained to control activation in rACC, thereby decreasing their ongoing chronic pain level.(39-41)

**AUTOGENIC BIOFEEDBACK TRAINING**

Autogenic training(AT) is a standardized relaxation technique as a self-hypnotic procedure, using the mental repetition of six systematic relaxation and body awareness exercises (heaviness, warmth, calm and regular heart function, self-regulation of respiration, warmth in the upper abdomen area, and agreeable cooling of the forehead) . It is found efficient

to decrease sympathetic tone,

to induce a general disconnection of the organism,

to reduce the body’s stress response and pressure,

to foster the mind’s ability to produce relaxation in the body,

to begin self-healing,

to teach participants bodies to respond to verbal commands

to “tell” their body to relax

to control certain physiological responses (e.g., body temperature, heart beat, blood pressure) on their own.

to improve psychological well-being and quality of life in people living with chronic physical health problem.

The core of AT is standard exercises that focus on six physical manifestations of relaxation in the body:

1. Heaviness in the musculoskeletal system

2. Warmth in the circulatory system

3. Awareness of the heartbeat

4. Slowing down the breath

5. Relaxing the abdomen

6. Cooling the forehead

Exercises are built up weekly, in sequential order, starting with relaxing the peripheral extremities, then later adding practice with regulating the heart and circulatory system. Relaxing the respiratory system comes next followed by a focus on the visceral organs (the solar plexus area), and then, cooling the forehead. There is a final phase of feeling peace in the mind and body.

Although AT can also be used as a tool in professional psychotherapy , most of the evidence available comes from the study of AT as a relaxation technique. The mechanism of action of this relaxation technique lies in the relaxation response, as opposed to the stress response, which involves a complex interplay of the endocrine, immune, neurological, and psychological systems .

Four general physiological systems are candidates for most of the complaints or symptoms: the sympathetic branch of the autonomic nervous system (SNS), including the sympathetic adrenal medullary system; the parasympathetic branch of the autonomic nervous system (PNS); the respiratory system; and the hypothalamic–pituitary–adrenal system (HPA). **T**hree predominating themes can be categorized in the development of psychotherapies as “dynamic,” or “psychoanalytic,” “behavioral,” and “experiential.” “autogenic self-regulatory”.

The term autogenic is derived from the Greek words autos and genos and arer translated as “self-exercise” or “self-induction therapy.” AT is a conceptually sensible, physiological rationale and selfhypnotic suggestions thar are woven into a type of intervention linking “mind” and “body.” “Autogenic discharges,” are seen as a sudden and unpredictable form of “unloading” of pent-up thoughts, sensory processes, and muscular activity . They are differentiated as

(1) reactive discharges (i.e., responses to acute provocation);

(2) normally occurring spontaneous discharges (e.g., motor discharges during presleep stages);

(3) discharges that originate from the brain and characterize forms of pathology (e.g., epilepsy); and (4) discharges that may occur during sensory deprivation and during the practice of AT.

**Autogenic biofeedback training (ABT):**

AT is a system of psychosomatic self-regulation that was developed in Germany by Johannes H. Schultz, a psychiatrist and neurologist, early in the 20th century. This method permits the gradual acquisition of autonomic control through passive concentration on several standard repetitive verbal formulas (phrases) implying such subjective sensations as heaviness and warmth in the extremities.

The development of AT as a novel technique appears to be based on two sources: Schultz’s own experiences with clinical hypnosis and Oskar Vogt’s observations in brain research. Schultz himself noted that his hypnotized patients regularly reported two distinct sensations—an unfamiliar heaviness, especially in the limbs, and a similarly strange sensation of warmth. He was convinced that hypnosis was not something that the hypnotist actively did to the patient but something that the patient permitted to happen and, actually did to himself or herself. In order for the patient to enter into this state, there had to be a “switch,” a point of change. Provoking this switch—placing the control in the hands of the patient—was what Schultz wanted to achieve.

Oskar Vogt’s experiences further strengthened Schultz’s belief that it was possible to reliably trigger an autogenic state, because Vogt, a brain researcher, had reported to Schultz that his patients could volitionally produce the sensations of heaviness and warmth and could switch into self-hypnotic trance. . Over several years, Schultz further developed the idea of formulas to reliably achieve deep relaxation and its accompanying sensations in various parts of the body. The publication of his 1932 book on AT was the culmination of his efforts to standardize the procedure.

An important distinction must be drawn at the outset between the nomothetic and the idiographic knowledge. Nomothetic knowledge is general; idiographic knowledge is specific to a particular case. Much knowledge in psychiatry and psychology is generic derived from theory, research, and personal experience. Therapeutic interventions, interpretations, and prescriptions are always directed toward an idiograph: an individual person, couple, family, or group. The therapist is always in the position of asking him- or herself, “What is going on here with this particular case I am treating”.Biological and psychological phenomena are more complex and variable than those of the physical sciences. They are more difficult to classify and measure.

Autogenic means self-generating or produced from within. This reflects the ability to self-produce a relaxed feeling of warmth and heaviness throughout the body by saying various verbal phrases aimed at encouraging a state of physical relaxation and emotional calm. It is considered a form of self-hypnosis and is used to increase relaxation and restore balance in the body. It is a technique often recommended when a health issue is present and when stress is a contributing factor to producing or maintaining health issues.AT involves learning specific phrases that are repeated several times as silent thoughts to oneself. These phrases are performed in a detached way to encourage the body to produce a relaxed feeling of warmth, heaviness, and emotional calm. Research has found AT to be effective in the treatment of anxiety, mild to moderate depression, and functional sleep disorders.

Regular practice of AT has been found to reduce the frequency of migraine headaches and to be useful in the treatment of IBS by enhancing self-control.Autogenic training is commonly used to treat stress disorders, pain, and anxiety.AT is contraindicated for people with psychotic disorders. (42)

**NEUROFEEDBACK**

Since its inception in the 1960s, the concept of biofeedback has found diverse applications in fields such as psychology, medicine, parapsychology, business, and sports to enhance athletes' performance. One of the widely used biofeedback techniques is EEG biofeedback training (Electroencephalography), commonly known as neurofeedback (NFB), which represents a more sophisticated form of biofeedback, employing a technological self regulating stimulation method to restore brain functioning patterns and improve cognitive, emotional, and behavioral performance and refers to perception and learning of one’s own brain signals. NFB is not only the predecessor and an important part of the brain-computer interface (BCI) technology and an important aspect of neural engineering, but also one of the key technologies of brain–computer intelligent fusion .

Neurofeedback training, a non-invasive, safe, and effective means of regulating the nerve state of the brain,was initially applied to the prevention and rehabilitation of clinical nerve illness or mental illness and then gradually expanded to improve healthy individuals’ external performance and the relationship between sport performance and brain neural mechanism in motor behavior and excavate key neural charactersitics that can affect sport performance. Based on the signal modality, NFB includes electroencephalogram (EEG) NFB, functional magnetic resonance imaging (fMRI) NFB, and functional near-infrared spectroscopy (fNIS/fNIRS) NFB.

The analysis of EEG signals, captured using electrodes placed on the subject's scalp, is graphically presented and displayed on a monitor screen, providing feedback on the current changes occurring in their brain. The core principle of EEG biofeedback lies in the assumption that the brain's bioelectrical activity reflects the subject's emotional states and can be controlled and modified through training. EEG has been used to assess neuronal activity dynamics in the cerebral cortex, with different brain waves recorded, including theta (4–8 Hz), alpha (10–12 Hz), beta (22–15 Hz), and sensorimotor rhythm (12–15 Hz) in understanding the enhancement of cognitive-motor processes.

Neurofeedback began with experiments showing that humans could self-control electroencephalographic signals in real time. So, neurofeedback is a learning technique that leads to changes in brain wave patterns. Two lines of early research led to the development of NFB, one investigating consciousness and how the mind knows the brain and the other applying operant conditioning techniques to the behavior of producing brain waves. The most important development in the use of biofeedback in sport performance is the process of using selective brain-wave measures (neurofeedback) (NFB) to shape and improve attention, which is defined as the process of facilitating selection of stimuli from the environment to the exclusion of other stimuli, resulting in an appropriate response to relevant stimuli. A critical task necessary to achieve optimal performance in both open and closed sport events is the attainment of maximal concentration and attention to the most relevant details within the environment.

Neurofeedback is a kind of biofeedback, which teaches self-control of brain functions to subjects by measuring brain waves and providing a feedback signal and provides the audio and or video feedback. Positive or negative feedback is produced for desirable or undesirable brain activities, respectively. NFB utilizes measured changes in brain activation to assist athletes in regulating the activity or power of designated EEG frequency bands, offering them real-time activation information.In sports like judo, where visual attention and its contribution to decision-making and motor response planning are crucial for success, a high level of concentration and the ability to quickly react to visual stimuli are particularly important. Thus, It is recommended to focus on improving these skills (enhancing their visual processing mechanisms and response time to stimuli) in the training process of judo.

Reaction time, i.e., the time elapsed from perceiving a stimulus to reacting to it, serves as an indicator for assessing the internal cognitive-motor resources associated with an athlete’s performance. A principle from Roman times: mens sana in corpore sano (a sound mind in a sound body). This phrase exemplifies the idea of mind–body unity and means that both mind and body must be flexible, to be able to withstand stress, recover from stress, and return to a baseline characterized by a relaxed mind in tune with a relaxed body. Thus neurofeedback is not a stand-alone intervention; rather, a person trains the brain (NFB), the mind (using cognitive strategies), and the body (using regular biofeedback modalities) in order to be maximally effective and resilient. In general, it appears that NFB is a safe, noninvasive intervention that rarely produces negative side effects.

Neurofeedback is a psychophysiological procedure in which online feedback of neural activation is provided to the participant for the purpose of self-regulation. Learning control over specific neural substrates has been shown to change specific behaviours. As a progenitor of brain–machine interfaces, neurofeedback has provided a novel way to investigate brain function and neuroplasticity. The persistence of functional reorganization of the brain after the termination of neurofeedback training is an indicator of neuroplasticity

In neurofeedback, brain activation is volitionally regulated through learning; as the activation acts as an independent variable, for causal inferences to be made between brain activity and behaviour. The different behavioural changes from self-manipulation of neural activation indicate that the physiological consequences of neurofeedback may be considered to be a form of endogenous neural stimulation . Thus, neurofeedback has been used to modulate behaviourally relevant functional networks and to provide self-administered therapy.

Neurofeedback is a type of biofeedback in which neural activity is measured, and a visual, an auditory or another representation of this activity is presented to the participant in real time to facilitate self-regulation of the putative neural substrates that underlie a specific behaviour or pathology. Traditional functional neuroimaging establishes correlative relationships between brain activity and behaviour. Neurofeedback that involves functional neuroimaging enables the manipulation of neural activity in circumscribed regions, functional connections and spatiotemporal activity patterns as independent variables, and thus represents a way of investigating the relationship between brain activity and behaviour that is comparable to brain stimulation.

Neurofeedback has been used to self-regulate electroencephalography (EEG) amplitudes, which correlate with the degree of intracortical neuronal synchronization. Neurofeedback-mediated reductions in parieto-occipital EEG amplitudes boosted visual attention or curbed mind-wandering, and neurofeedback-mediated increases in intracortical neuronal synchronization elicited improvements in tasks requiring internal processing, such as mental rotation or musical performance. Functional MRI (fMRI)-based neurofeedback that involved learning to increase or decrease activity in distinct cortical and subcortical regions of interest (ROIs) has been used to modulate behaviour. The correlated activation of two neural substrates is termed ‘functional connectivity’ in haemodynamic modalities and ‘coherence’ in electrophysiological terms. ‘Connectomics’ is emerging as the predominant scientific philosophy for understanding human brain function and dysfunction.

Neurofeedback-induced neuroplasticity, in the form of cortical excitability changes, has been demonstrated in humans by using transcranial magnetic stimulation (TMS) on the trained brain region. TMS pulses were applied to the motor cortex to measure motor-evoked potentials after learned self-regulation, without regulation or under other control conditions to probe for neuroplastic changes in the strength (that is, the excitability) of the corticospinal pathway. Learning to control brain activity in humans is determined by contingent feedback and reward, and potentially by verbal instructions and mental strategies (for example, use of imagery) that are suggested by the experimenter to the participant.

The explanatory hypothesis of neurofeedback are:

Operant (or instrumental) learning

The operant learning theory, as applied to neurofeedback, states that control of brain activity proceeds when correct or desired brain responses are reinforced by contingent feedback and/or reward. The theory considers three main elements in its description of the procedure, discriminative stimuli, responses and reinforcers.

Motor learning

According to this model, acquiring control over neurophysiological signals is similar to the acquisition of motor learning involving a well-organized sequence of movements and symbolic information.

Dual process theory

The dual process theory attempts to integrate feed forward and feedback learning processes in explaining neurofeedback learning.

Awareness theory

The awareness theory competes directly with the instrumental learning model in biofeedback literature. The theory states that the feedback signal provides information about a physiological response (that is, brain activity) to which the subject becomes aware of, and this leads to voluntary control over the response. The model considers three elements, awareness of reinforcers (feedback and reward), the reinforcer response contingency and the response itself.

Global workspace theory

The global workspace theory of neurofeedback learning proposes that learning control of neural activity is enabled by the wide, global distribution of the feedback signal in the brain so that it becomes conscious .

Skill learning

there have been proposals to view neurofeedback and brain– computer interfaces (BCI) or brain–machine interfaces (BMI) learning within the framework of cognitive skill learning. According to thisproposal, neurofeedback learning involves an initial phase of rapid change in performance and a late phase of more gradual improvement as the skill is consolidated and performance asymptotes. Functional and structural changes in the dorsomedial striatum have been shown to be associated with the early phase, whereas such changes in the dorsolateral striatum have been shown to be associated with the late phase. .

Whereas neuroscience applications of neurofeedback have attempted to elucidate the causal relationship between brain and behaviour, clinical applications have attempted to exploit neurofeedback for the treatment of brain and behavioural disorders. Traditionally, two types of unipolar and bipolar montage are used in the neurofeedback treatment. In unipolar mode, the active electrode is placed on the skull and the recorded signal by the active electrode is compared to the second electrode entitled as the reference electrode.

The activity of the active electrode minus the activity of the reference electrode represents the brain activity at the active electrode. On the other hand, in the bipolar mode, two active electrodes are used that are separately placed on the skull. The difference between the recorded signals by these 2 electrodes, is the basis of the neurofeedback

There are 7 types of Neurofeedback for the treatment of various disorders:

1)Frequency/Power Neurofeedback.

The most frequently used neurofeedback is frequency/ power neurofeedback. This technique typically includes the use of 2 to 4 surface electrodes, sometimes called “surface neurofeedback”. It is used to change the amplitude or speed of specific brain waves in particular brain locations to treat ADHD, anxiety, and insomnia.

2) Slow cortical potential neurofeedback (SCP-NF) improves the direction of slow cortical potentials to treat ADHD, epilepsy, and migraines.

3) Low-energy neurofeedback system (LENS) delivers a weak electromagnetic signal to change the patient’s brain waves while they are motionless with their eyes closed . This type of neurofeedback has been used to treat traumatic brain injury, ADHD, insomnia, fibromyalgia, restless legs syndrome, anxiety, depression, and anger.

4) Hemoencephalographic (HEG) neurofeedback provides feedback on cerebral blood flow to treat migraine

5) Live Z-score neurofeedback is used to treat insomnia. It introduces the continuous comparison of variables of brain electrical activity to a systematic database to provide continuous feedback

6) Low-resolution electromagnetic tomography (LORETA) involves the use of 19 electrodes to monitor phase, power, and coherence.This neurofeedback technique is used to treat addictions, depression, and obsessive-compulsive disorder

7) Functional Magnetic Resonance Imaging (fMRI) is a research-based method using electrodes to map out the inner workings of the brain.

There are two classical directions in neurofeedback training. It is either focusing on low frequencies (alpha or theta) to strengthen relaxation and focus or emphasizing on high frequencies (low beta, beta, and theta) for reinforcing activation, organizing, and inhibiting distractibility. Children with autism have difficulty in functions such as qualitative impairment in social interactions related to mutual interest, verbal and nonverbal communication, understanding others’ intentions, behavior and interests, emotional reciprocity , even mental retardation, or seizure disorders. These children may also have extreme sensitivity to sounds and smells and may show idiosyncratic behaviors, obsessive rumination, poor social interrelatedness.

Empathizing deficits are consistent with problems in reciprocating communication, difficulty in predicting thoughts and feelings of others, interpreting abstract emotions of others, and an appearance of social insensitivity.Researchers found out that decreasing frontal electromyogram (EMG) levels by EMG biofeedback with alpha training can alleviate both generalized and specific anxiety patterns , since anxiety inhibits alpha waves.

Pain is considered a symptom associated with physical damage, purportedly having an objective element connected with the sensation. Neurofeedback methodology proposes that by teaching self-regulation, a patient can reduce or even eliminate pain sensations. Studies suggested that brain changes its functional organization at the level of the somatosensory cortex in chronic pain patients. Researchers recommend the use of biofeedback/neurofeedback for pain management. Biofeedback protocols are designed to address the peripheral correlation of arousal, such as temperature, heart rate variability, and muscle tension while neurofeedback directly affects the processing of pain perception.

Other successfull applications of neurofeedback include rehabilitation after stroke in the recovery from an injury , for example improvement of memory by increasing alpha activity, treatment of headache and migraines, distraction, confusion, attention problems, withdrawal , health promotion , treatment of mental illness, eating disorders, Parkinson disease, fibromyalgia, restless legs syndrome, obsessive compulsive disorder , and obsession .

Meanwhile, artists and surgeons use neurofeedback to improve their music performance and their microsurgical operations respectively. Alpha-EEG/EMG biofeedback is capable of increasing voluntary self-regulation and the quality of performance.  (43-44)

**HEART RATE VARIABILITY BIOFEEDBACK (HRBV)**

Heart rate variability biofeedback (HRVB) is a method that produces acute increases in heart rate variability (HRV), and increases resting HRV, reflex strength of two regulatory reflexes (the baroreflex and respiratory sinus arrhythmia), and improves various psychological and physical stress symptoms, and human performance. The first documented studies of HRVB were used to assess autonomic function and teach cosmonauts to produce high amplitudes of HRV and blood pressure variability at various frequencies. HRBV has been proposed for a variety of disorders and performance enhancement as well as asthma and depression which responded to cardiorespiratory feedback training. The mechanism is the strenghtening of homeostasis in the baroreceptor and the effect on the vagal afferent pathway to the frontal cortical areas. Additionally HRV biofeedback produces body autonomic activity , which is characteristic of relaxation by stimulating parasympathetic reflexes, called accentuated antagonism, that can be strenghtened with HRBV training to improve emotional health and life quality in patients of anxiety, depression, insomnia and anger[https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR4) and other psychiatric disorders , as well as pain[https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR9), asthma[https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR10), or pre-hypertension and [https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR11) performance in elite athletes through enhancing psychophysiological variable , the athletic and artistic performance.

People are more physically and emotionally resilient when HRV oscilaltion amplitudes are higher. Greater complexity , measured by various fractal entropy calculations, suggest an operation of multiple regulatory feedback loops. It is a physicl principle that all oscilalting feedback systems with a constant delay hav ethe charactreisitc of resonance. A resonant system , when stimulated , produces high amplitude oscillations at single frequency, recruiting or overshadowing other frequencies to produce sine-waveoscilaltion of high amplitude. Heart Rate Variability Biofeedback (HRVB) (also called Resonance Frequency Biofeedback) is a relaxation technique based on breathing training at the resonance frequency (RF), or optimal breathing at a frequency that produces maximal respiratory sinus arrhythmia (RSA) and corresponds to the baroreflex (BR).

HRVB is a good method for controlling autonomic modulation[https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR19), and its training increases Heart Rate Variability (HRV)[https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR20), which is defined as the fluctuations in the time interval between consecutive beats. In the scientific literature it is accepted that the greater the cardiac variability the better the general health, both physical and emotional, and that HRVB as a valid method to increase heart rate variability with beneficial effects. HRV has been considered an index of autonomic resilience to assess the autonomic balance between the sympathetic and the parasympathetic system[https://www.nature.com/articles/s41598-021-87867-8](https://www.nature.com/articles/s41598-021-87867-8#ref-CR22) since it reflects the ability to recover from exposure to both physical and psychological stressors.

Heart rate is the number of heartbeats per minute. Heart rate variability (HRV) is the fluctuation in the time intervals between adjacent heartbeats . HRV, which is generated by heart-brain interactions and dynamic non-linear autonomic nervous system (ANS) processes, indexes neurocardiac function and reflects regulation of autonomic balance, blood pressure (BP), gas exchange, gut, heart, and vascular tone, which refers to the diameter of the blood vessels that regulate BP. Heart rate variability (HRV) consists of changes in the time intervals between consecutive heartbeats called interbeat intervals (IBIs). A healthy heart is not a metronome. The oscillations of a healthy heart are complex and non-linear and allow the cardiovascular system to rapidly adjust to sudden physical and psychological challenges to homeostasis by constantly changing. A healthy heart’s beat-to-beat fluctuations are best described by mathematical chaos . The variability of non-linear systems provides the flexibility to rapidly cope with an uncertain and changing environment. While healthy biological systems exhibit spatial and temporal complexity, disease can involve either a loss or increase of complexity .

Higher HRV is not always better since pathological conditions can produce HRV. Elevated HRV measurements due to cardiac conduction abnormalities, may be linked to increased risk of mortality (particularly among the elderly). Close examination of electrocardiogram (ECG) morphology can reveal whether elevated HRV values are due to problems like atrial fibrillation .An optimal level of HRV is associated with health and self-regulatory capacity, and adaptability or resilience. Higher levels of resting vagally-mediated HRV are linked to performance of executive functions like attention and emotional processing by the prefrontal cortex. Afferent information processing by the intrinsic cardiac nervous system can modulate frontocortical activity and impact higher-level functions .

HRV serves as a complex biomarker, providing crucial understandings into the operations of the autonomic nervous system. HRV parameters can be classified into linear and non-linear categories. Linear parameters are derived from the time domain (TD), frequency domain (FD), and geometric parameters (GD), while non-linear parameters utilize the irregularities in the time series derived from the complexity of the mechanisms that regulates HRV . Clinicians and researchers measure HRV using time-domain, frequency-domain, and non-linear indices.

**Time Domain Analysis:** Of the different analyses available, time-domain parameters provide a direct method for calculating HRV.  Recording period length strongly influences time-domain values. Shorter epochs are associated with smaller values and poorly estimate 24 h values . *Time-domain* indices of HRV quantify the amount of variability between the interbeat intervals (IBI), which is the time period between successive heartbeats that may range from <1 min to >24 h.Heart rate variability time-domain measurements decline with age and decreased health but rise with increased aerobic fitness.

**Frequency Domain Analysis:** Complex FD parameters, including Very Low Frequency (VLF), Low Frequency (LF), High Frequency (HF), and the HF/LF ratio, are essential for assessing the influence of the autonomic nervous system on HRV, with data extracted either from a 24-h Holter ECG record or short-term recordings lasting 2–5 min . Frequency-domain measurements estimate the distribution of absolute or relative power into four frequency bands. The Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996) divided heart rate (HR) oscillations into ultra-low-frequency (ULF), very-low-frequency (VLF), low-frequency (LF), and high-frequency (HF) bands. Minimum recommended periods include: ULF (24 h), VLF (5 min, 24 h preferred), LF (2 min), and HF (1 min). Short-term epochs (~5 min) lack the prognostic power of 24 h measurements for morbidity and mortality. The recording length is recommended to be at least 10 times the wavelength of the lower frequency bound, with an absolute minimum of 1 min recording for HF components, 2 min recording for LF components and 10 min recording for VLF component.

HRV frequency-domain measures:

| **Parameter** | **Unit** | **Description** |
| --- | --- | --- |
| ULF power | ms2 | Absolute power of the ultra-low-frequency band (≤0.003 Hz) |
| VLF power | ms2 | Absolute power of the very-low-frequency band (0.0033–0.04 Hz) |
| LF peak | Hz | Peak frequency of the low-frequency band (0.04–0.15 Hz) |
| LF power | ms2 | Absolute power of the low-frequency band (0.04–0.15 Hz) |
| LF power | nu | Relative power of the low-frequency band (0.04–0.15 Hz) in normal units |
| LF power | % | Relative power of the low-frequency band (0.04–0.15 Hz) |
| HF peak | Hz | Peak frequency of the high-frequency band (0.15–0.4 Hz) |
| HF power | ms2 | Absolute power of the high-frequency band (0.15–0.4 Hz) |
| HF power | nu | Relative power of the high-frequency band (0.15–0.4 Hz) in normal units |
| HF power | % | Relative power of the high-frequency band (0.15–0.4 Hz) |
| LF/HF | % | Ratio of LF-to-HF power |

*Power* is the signal energy found within a frequency band. Frequency-domain measurements can be expressed in absolute or relative power. *Absolute power* is calculated as ms squared divided by cycles per second (ms2/Hz). *Relative power* is estimated as the percentage of total HRV power or in normal units (nu), which divides the absolute power for a specific frequency band by the summed absolute power of the LF and HF bands.

**Non-linear Analysis:** The heartbeat's underlying dynamics, steered by interactive cardiovascular control systems, being too multifaceted to be entirely depicted using standard analyses led to the development of non-linear HRV parameters utilizing the principles of non-linear dynamics. While linear HRV parameters (barring geometric parameters) are susceptible to artifacts and missed beats, their non-linear counterparts are robust against these anomalies.

Two distinct but overlapping processes generate short-term HRV measurements. The first source is a complex and dynamic relationship between the sympathetic and parasympathetic branches. The second source includes the regulatory mechanisms that control HR *via* respiratory sinus arrhythmia (RSA), the baroreceptor reflex (negative-feedback control of BP), and rhythmic changes in vascular tone. *RSA* refers to the respiration-driven speeding and slowing of the heart *via* the vagus nerve.

In a healthy human heart, there is a dynamic relationship between the PNS and SNS. PNS control predominates at rest, resulting in an average HR of 75 bpm. The PNS can slow the heart to 20 or 30 bpm, or briefly stop it. This illustrates the response called *accentuated antagonism* . Parasympathetic nerves exert their effects more rapidly (<1 s) than sympathetic nerves (>5 s).  *Parasympathetic rebound* may occur following high levels of stress, resulting in increased nighttime gastric activity and asthma symptoms. The relationship between the PNS and SNS branches is complex (both linear and non-linear . Increased PNS activity may be associated with a decrease, increase, or no change in SNS activity. For example, immediately following aerobic exercise, HR recovery involves PNS reactivation while SNS activity remains elevated.

The autonomic, cardiovascular, central nervous, endocrine, and respiratory systems, and baroreceptors and chemoreceptors influence HRV over a short time period and contribute to the very-low to high frequencies of the HRV spectrum . Baroreceptors, which are BP sensors located in the aortic arch and internal carotid arteries, contribute to short-term HRV. The baroreflex links HR, BP, and vascular tone. Oscillation in one cardiovascular function causes identical oscillations in the others. Baroreceptor firing due to BP changes activates mechanisms that change HR and vascular tone. Rising BP triggers decreases in HR and vascular tone, while falling BP causes increases in both.

Autonomic efferent neurons and circulating hormones modulate SA node initiation of heartbeats. The interdependent regulatory systems that generate the complex variability of a healthy heart operate over different time scales to achieve homeostasis and optimal performance. Circadian oscillations in circadian variations in core body temperature, metabolism, sleep–wake cycles, and the renin–angiotensin system contribute to 24 h HRV measurements, which represent the “gold standard” for clinical HRV assessment. The complex dynamic relationship between the sympathetic and parasympathetic branches, and homeostatic regulation of HR *via* respiration and the baroreceptor reflex are responsible for short-term and ultra-short-term HRV measurements. Since slower regulatory mechanisms contribute to HRV metrics recorded over longer measurement periods, 24 h, short-term, and ultra-short-term values are not interchangeable. In short-term resting recordings, the primary source of the variation is parasympathetically-mediated RSA, especially with slow, paced breathing (PB) protocols.

The relationship between non-linear measurements and illness is complex. While stressors and disease lower some non-linear indices, in cases like myocardial infarction, higher non-linear HRV predicts a greater risk of mortality. Heart rate variability (HRV) is an important physiological biomarker of wellbeing, mood, and adaptation, and hence improvements in HRV signify improved health, mood, and adaptation to stress. Resonance breathing has consistently been shown to increase HRV, mood, and adaptability. Heart rate accelerates during inspiration and slows during expiration.

Urbanisation, changing lifestyles, and competitive streaks in all spheres of life have made anxiety, stress, depression, and resultant psychosomatic illnesses an inevitable part of human life. Stress and autonomic dysfunction are the common risk factors for future cardiovascular disease (CVD) and also negatively impact cognitive functions. Heart rate variability (HRV), which is a non-invasive physiologic measure of autonomic function defined as oscillations between consecutive heartbeats, is an index of the autonomic balance that facilitates the identification of people at the risk of developing cardiovascular complications and reflect the efficiency of the body's response mechanism to diverse stimuli, emphasizing physiological stability . Different mental states, such as relaxation or stress, can substantially alter HRV parameters. For example, relaxation amplifies HRV parameters owing to parasympathetic dominance, whereas stress reduces them because of heightened sympathetic activity. Heart rate variability (HRV) is a crucial metric that provides valuable insight into the balance between relaxation and stress.

HRV is the change in the time intervals between successive heartbeats, facilitating adaptability to environmental and psychological challenges . This low-cost, non-invasive technique serves as a metric for cardiac autonomic modulation. Distinct pathological and non-pathological circumstances, ranging from cardiovascular diseases to psychological conditions, can alter HRV, positioning it as a potential [health indicator](https://www.sciencedirect.com/topics/medicine-and-dentistry/health-indicator) as a biomarker for various conditions such as [vascular tone](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/blood-vessel-tone), which is essential for [blood pressure regulation](https://www.sciencedirect.com/topics/medicine-and-dentistry/blood-pressure-regulation) and heart function.

Autonomic cardiac dysregulation is a critical process that underlies the manifestation and perpetuation of broad spectrum symptoms of poor health. HRV has been shown to be useful in predicting morbidities from common mental (e.g., stress, depression, anxiety, PTSD) and physical disorders (e.g., inflammation, chronic pain, diabetes, concussion, asthma, insomnia, fatigue), all of which increase sympathetic output and create a self-perpetuating cycle that produces autonomic imbalance and greater allostatic load. Thus, ANS dysfunction is a systemic common denominator of poor health and associated with acute and chronic illness and a risk factor for such serious health issues as cancer survivorship, cardiovascular disease and myocardial infarction, stroke, and overall mortality.

HRV parameters are valuable indicators of an individual's [physiological response](https://www.sciencedirect.com/topics/medicine-and-dentistry/physiological-response) to stress and relaxation. During a mentally stressful state, HRV parameters differ significantly from those during a mentally relaxed state. Under stress, a reduced vagal tone indicates an elevated sympathetic response. Conversely, enhanced vagal tone during relaxation points toward a healthier autonomic balance and increased parasympathetic response. (45-49)

**BREATHING THERAPY**

Optimal breathing is often described as something that occurs in the perfectly healthy person who is in a state of physical rest and emotional ease. While the Indian yoga literature describes optimal breathing in a person with peak physical health and emotional ease as slow, regular, even, diaphragmatic and nasal, Taoist yoga describe perfect breathing as inaudible and “so smooth that the fine hairs within the nostrils remain motionless”. Stress, emotion and cognitive process can simultaneously affect breathing and speech mechanisms producing dysfunctional muscle tension. Paradoxical vocal cord dysfunction, a condition often misdiagnosed as asthma, which often results from severe psychosocial and intense emotion stress, is associated with respiratory difficulty and tense patterns of breathing.

In conditions such as muscle tension dysphonia, speech muscles contract inappropriately and are incorrectly coupled with inspiration rather than expiration. In muscle tension dystonia, breathing is inadequate to support proper voice production and most patients show signs of tension in the neck muscles which also function as accessory muscles of respiration. Attention to correct breathing and relaxation can assist these speech dysfunctions Breathing regulation is effective in changing one‟s emotional state and response to stress. It has been reported that voluntary breath modulation accounts for 40% of the variance in positive feelings such as joy and negative feelings such as fear, sadness and anger. Breathing has been shown to calm both mind and body, increase resilience in stressful situations and dampen levels of psychological and physiological arousal. Numerous studies have also shown that conscious control of breathing improves anxiety, depression and panic disorder.

Breathing influences sympatho-vagal balance and can produce shortterm amplification of parasympathetic activity during a stressful task. Regular practice of slow controlled breathing increases basal parasympathetic activity and reduce sympathetic activity. The increased activity of the parasympathetic nervous system encouraged by certain types of controlled breathing promotes homeostasis and assists recovery and restoration of function in body systems disturbed by stress. The sympathetic dampening and parasympathetic promoting effects of breathing on autonomic nervous system function have been seen in patients with chronic obstructive pulmonary diseases, essential hypertension and other diseases. Dynamic breathing practices, which actually stimulate the activity of the sympathetic nervous system, by increasing respiratory rate, and alternating changing rhythms, may be useful in re-setting neuro-endocrine components of the stress response when they are used in combination with calming practices.

Oscillations or fluctuations of activity within systems are vital to homeostasis and regulation because they increase adaptability and coordinated interaction of systems to changes in environmental conditions. Breathing functions as an oscillating system that also interacts with other oscillating systems, influence the feedback mechanisms that maintain homeostasis in systems such as the baroreflex and the cardiovascular system through its ability to affect the fluctuations in pressure and autonomic nervous function. Breathing can be consciously manipulated to entrain other oscillations and increase physiological regulation. When breathing frequency is slowed to between 4 and 6 breaths per minute (0.06-0.1Hz), oscillations in blood pressure, heart rate and autonomic nervous system tend to synchronize at this frequency and be amplified due to resonance effects between these systems.

Specific frequencies of breathing can improve coupling between body systems and result in improved physiological efficiency. The resonance effects between cardio respiratory oscillations and autonomic function, produced by breathing rates of around 0.1 Hz, have implications for health as evidenced by the fact that regular practice assists people with a range of conditions including asthma, COPD, depression, hypertension and irritable bowel syndrome. Breathing rhythms can be disturbed in disease or as a result of psychological stress (unlike other oscillations) breathing can be brought under conscious control to provide an avenue for physiological self-regulation.

As a brıdge between mınd and body regarding the somatıc perspectıve, breathing is highly responsive to, and reflects levels of, physiological and psychological arousal and metabolic activity. The breath is referred to as a bridge, connector or channel between the body and mind because of the inter-relationship between emotions, mental processes, patterns of body tension and breathing. The breath functions as an indicator of psychological states. There is a tradition of breathing therapy, that increases self-awareness of breathing for better self-regulation.

Western modern somatic psychotherapies such as Reichian Therapy and Middendorf Breathing Therapy describe the breath as being a conduit to an expanded self-awareness which is beyond normal day-to-day awareness and which allows a personto access suppressed feelings, the body‟s innate wisdom and the subconscious mind. It is also believed that becoming aware of, and fully sensing, the natural breath connects a person with the deeper levels of their psyche and thus supports physical and psychological integration as a process of holding on the “guide rope of the breath until the clarity of consciousness can develop out of the unconscious”.

Many of the world‟s major religions include practices that utilise the breath for spiritual purposes. They claim that the breath is a means to control the mind and body, and a pathway to spiritual attainment. In Middle Eastern religions, including Sufism and the mystical branches of the Jewish religion, breathing practices are combined with movement, intonation of sacred syllables and phrases and particular types of visualization. The Sufis claim that the supreme value of breath is its ability to connect one with divine consciousness.

The Upanishads, ancient Hindu scriptures that constitute the core teachings of Vedanta and form the basis of modern Yoga, refer to the use of breath control and breath attention as means to refine consciousness and achieve states of bliss and transcendence. In Yoga, breath control is claimed to be the key to gaining the mental control needed for spiritual development. In Buddhism, regular and extensive practice of mindful attention to the breath is a core practice for spiritual development.

In a number of cultures, the breath is equated to spirit or vital energy and breathing practices are credited with the ability to enhance and control the movement of this vital energy or life force. The word for breath and the word for life force or vitality are one and the same in many languages, e.g. in India the term prana is used, in China the equivalent term Qi is used, in Tibet the term is lung, in Islam it is baraka and in Hebrew, ruach, Kalahari Bushmen use the term num and the Lakota Sioux use the term neyatoneyah. The ancient Greeks made a connection between the function of the diaphragm and the breath, with the mind. The Greek word phren means mind and refer to the nerve which innervates the diaphragm as the phrenic nerve.

There is a long tradition of using breathing as a salutogenic tool to enhance wellbeing and as a therapeutic tool to treat disease. In Indian and Chinese Taoist yoga, the salutogenic and therapeutic potency of breath control, are explained in terms of its ability to influence life force (Prana and Qi) and also to calm the nervous system and reduce stress. In Chinese Taoist yoga it is believed that a person who practices breathing control is able to prevent disease and prolong life. Breathing therapy has also been found to be very helpful for cardiovascular disease. The effectiveness of breathing therapies in psychological conditions and chronic stress has also been shown in several studies. In major depression, both resonant frequency biofeedback and modern yoga derived breathing techniques appear to be effective.

People with anxiety and panic disorder show beneficial response to capnometry and other breathing therapy protocols. Psychological and emotional states influence respiratory control and respiratory rhythm generation.Respiration is primarily regulated for metabolic and homeostatic purposes in the brainstem. Autonomic breathing is not only controlled by metabolic demands but also constantly responds to changes in emotions, such as sadness, happiness, anxiety and fear. Final respiratory output is influenced by a complex interaction between the brainstem and higher centres, including the limbic system and cortical structures. Respiration is important in maintaining physiological homeostasis and co-exists with emotions

Emotions involve physiological changes within the entire body. In humans, the relationship between emotions, increases of heart rate and blood pressure have been investigated. Relationships between emotions and respiration have shown more rapid breathing during an arousal state. Respiration, is altered by emotions changes, for example when subjects look at photographs, which induces emotional changes. In respiratory patterns, respiratory rate is changed dramatically by emotional changes related to individuality and the personality differences in the patterns of breathing during mental stress and physical load. Levels of individual anxiety affect respiratory rate, especially the expiratory time. Identical twins breathe in similar ways.

Anticipatory anxiety, which has been defined as the time between the warning presentation and stimulation, increases the respiratory rate related to metabolic demand and not to O2 consumption. Respiratory changes in response to anxiety are affected by higher centres related to the emotion and positively correlated with individual trait anxiety scores. During the sensation of air hunger (an uncomfortable urge to breathe) induced by mechanical ventilation at a low tidal volume, the limbic and paralimbic loci are activated in normal subjects. Dyspnoea or breathlessness, depends on the affective state of the subject.

Respiratory sensation and changes in respiratory pattern are involved or elicited by anxiety and distress. Respiratory-related activities being estimated in the human brain using functional magnetic resonance imaging (fMRI). In an animal study that electrical stimulation of the amygdala increases respiratory rate with specific signs of fear, including various autonomic and physiological responses. In various perceptions of sensations that influence or produce emotion, odours are dependent on respiration; because the sense of smell is enhanced by inhalation or inspiration. Olfactory information ascends directly to limbic areas without relaying through the thalamus, activated directly from each breath. Direct stimulation of the olfactory limbic areas unconsciously alters the respiratory pattern. Unpleasant odours increase respiratory rate and induce rapid shallow breathing, even before subjects discern whether a smell is unpleasant and pleasant odours induce deep breathing. Physiological outputs respond more rapidly than cognition.

Electroencelphalography studies with the advantage of temporal resolution have shown that during inspiration three to four negative and positive waves, which are phase-locked α-band oscillation (I-α) to inspiration, are not observed during the expiratory phase or during breathing of normal air. Oscillations can be classified into fast waves with frequencies >1.5 Hz and slow waves with frequencies <1.5 Hz. Fast oscillations show low amplitude and are observed during awake or rapid eye movement (REM) sleep. Slow oscillations show high amplitude during non-REM slow-wave sleep and while under general anaesthesia.

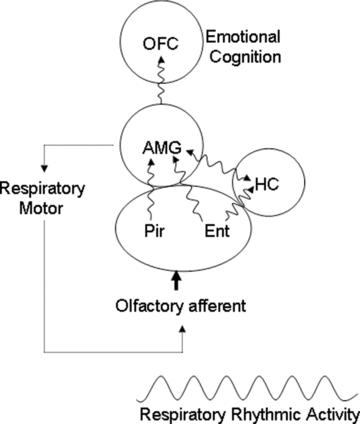
The piriform–limbic system rhythmic activity, which is independent of C4 inspiratory activity, remains after complete separation of higher brain regions from the lower brainstem by sectioning at the level of the pons. While electrical stimulation applied to this region induces a C4 inspiratory burst; if applied to the ventrolateral medulla (VLM), where the brainstem respiratory rhythm generator exists, induces an excitatory response in the dorsal amygdala complex . Neurons in the amygdala complex are connected reciprocally with respiratory regions in the medulla and pons .

Humans breathe throughout their lives; from birth to death, our breaths are always changing, and no single breath is identical to another. The primary goal of the respiratory system is to maintain arterial blood gas homeostasis. Swallowing, coughing, sighing, and other nonrespiratory motor acts reset the respiratory rhythm produced by the respiratory central pattern generator (rCPG) in the brainstem. Respiratory neurons are involved in generating the spatiotemporally organized activities associated with coughing and swallowing, and respiratory neuronal networks are also shared by nonrespiratory networks. Spatial network reorganization, i.e., the expansion and contraction of the active network during the inspiratory phase of breathing, occurs within the rCPG via a balance between excitation and inhibition . This network sharing and reorganization contribute to the fexibility and variability of breathing.The response to an emotion in the respiratory pattern is afected by the personality even at rest

The respiration–emotion relationship is bidirectional. Deep and slow breathing (DSB) ameliorating efects of DSB on anxiety are mediated by reinforcement of the vagal tone, which balances sympathetic and parasympathetic activity. Human subjects can adjust their respiratory cycle to the onset of cognitive tasks. Various diseases afect respiratory variability. Breathing variability is remarkably augmented in patients with anxiety disorders, such as panic disorder . The ventilatory flow of healthy, quietly breathing subjects exhibits nonlinear dynamics that are indicative of chaos. The chaotic feature of respiratory variability is neurogenic.

Volitional and emotional controls of breathing can take control over the pattern of breathing, either consciously or unconsciously, via direct projections to respiratory motoneurons and projections to diverse respiratory control areas in the midbrain, pons, and medulla oblongata. Normal breathing consists of three phases: inspiration, postinspiration, and late expiration. The three-phase rhythm requires the integrity of the pontine–medullary respiratory network. The spontaneous oscillatory activity initiated in the piriform–amygdala complex, which is associated with respiratory activity in the medulla, may control respiratory rhythm when it is activated by an odorant or during various emotions.Respiration can be used to express and control emotion to organize brain-wide network oscillations via cross-frequency coupling, optimizing cognitive performance. With the aid of information theory-based techniques and machine learning, the hidden information can be translated into a form usable in clinical practice for diagnosis, emotion recognition, and mental conditioning.

Odour perception and odour-induced emotions are dependent on inspiration. Respiratory rhythms are closely associated with emotions. The piriform cortex may produce rhythms, and the piriform–amygdala complex may alter respiratory rhythm in response to qualitative changes in emotions. The entorhinal cortex may also be necessary in this system. This system may be involved not only in odour stimulation but also in various emotional states. Breathing and emotion are linked with meditation, especially in East Asia. Breathing and emotion are also linked with culture.



**Fig.3. Schematic representation of connections of orbitofrontal cortex (OFC), amygdala (AMG), piriform cortex (Pir), entohinal cortex (Ent) and hippocampus (HC) with respiratory rhythm** (50).

Breathing plays a crucial role in shaping perceptual and [cognitive processes](https://www.sciencedirect.com/topics/neuroscience/cognitive-process) by regulating the strength and synchronisation of [neural oscillations](https://www.sciencedirect.com/topics/neuroscience/neural-oscillation).Respiration is vital for maintaining homeostasis and adapting to environmental demands. While gas exchange is its primary physiological function, respiration also impacts heart rate variability and blood flow, leading to alterations in brain activity , stress reduction, and the regulation of emotional and [cognitive processes](https://www.sciencedirect.com/topics/neuroscience/cognitive-process) . Respiration directly influences rhythmic brain activity and sensory, affective, and cognitive functions beyond gas exchange physiology.

Respiration creates both conscious and unconscious streams of rhytmic sensory inputs to the brain. Consciously accesible sensations of normal , unobstructed breathing include odor perception, the mechanical and thermal sensation of air flowing thorugh nose, mouth and upper airways, and the proprioception of movements of the chest and abdomen. Unconscious sensory signals caused by respiration include interoceptive signals from the lungs, diaphragm and internal organs, which represent teh mechanical consequences of respiratory movements and the chemosensitive signals from the cardiovascular system , which represent bretah by breath fluctuations of CO2 and O2 levels in the blood.

There are a number of indirect ways cortical areas receive respiration locked sensory input. Eye movements, have been shown to be transiently phase locked to respiration during sleep as well as in awake state. The retinal flow associated with eye movements causes a modulation of power in visual cortical oscillations that is partially correlated with respiration. Another indirect respiration locked sensory input comes from the auditory cortex, which receives rhytmic auditory input related to respiration caused by the sound of air flowing through the nose or mouth. Projections from the neurons in the brain stem to thalamic nuclei, provide respiration locked input to the thalamus introducing a non-sensory respiartory rhytm to the thalamo-cortical network.

EEG studies comparing nasal and oral breathing of room air found that nasal breathing elicited significantly different patterns of EEG activity than mouth breathing. Respiration related sensory activity during unobstructed breathing mainly reaches three areas of the cortex:

(1) the olfactory cortex and surrounding areas receive olfactory bulb input;

(2) the somatosensory cortex receives inputs from mechanoreceptors of chest, the abdominal skin and muscles that are stretched and moved by respiration; and

(3) the insular cortex receives input from chemoreceptors and mechanoreceptors in the lungs, diaphragm and internal organs.

Respiration-locked rhythmic inputs drive cortical neurons to fire rhythmically at the same frequency. Respiration has implicated in the modulation of pain perception which is reduced during inspiration. Slow breathing reduces the perceived severity of pain. The strenght of cortico-spinal communication is modulated in phase with respiration. Interactions between respiration and sensory motor processes are caused by respiration locked fluctuations of ongoing neuronal activity in motor and sensory cortical areas.During nasal breathing, olfactory receptor neurons fire rhythmically in phase with respiration and drive activity in olfactory bulb (OB) mitral and tufted cells.

Respiratory rhythms in directly modulate neural oscillations through phase-amplitude coupling and neural excitation control. Oscillations are a fundamental organising principle in biological organisms, governing both neural processing and bodily rhythms. The rhythmic activity of breathing directly impacts neural oscillations across multiple brain regions, behaviours, and frequency bands. Human respiration at rest comes naturally by means of active (but automatic) inspiration and passive expiration. Each breath is initiated and coordinated by coupled oscillators periodically driving rhythmic respiration. This pacemaking microcircuit controls respiration autonomously, making the act of breathing effortless. Respiration is also under top-down control: Cortical projections can influence the primary respiratory network, e.g. when breathing is adapted to laughter or crying or at transitions between brain states (e.g. changes in arousal or targeted attention).

In addition to the bottom-up pathway, there is a second pathway feeding back direct projections from receptors within the nasal cavity: With every breath, airflow within the respiratory tract triggers [mechanoreceptors](https://www.sciencedirect.com/topics/neuroscience/mechanoreceptor) connected to the [olfactory bulb](https://www.sciencedirect.com/topics/neuroscience/olfactory-bulb), the brain’s first olfactory relay station where the mechanical rhythms are translated into infraslow [neural oscillations](https://www.sciencedirect.com/topics/neuroscience/neural-oscillation) such that their phase closely follows that of the respiratory rhythm (*phase-phase coupling*). This mechanism is commonly termed cross-frequency *phase-amplitude coupling*, a well-established mechanism of neural information transfer across spatiotemporal scales

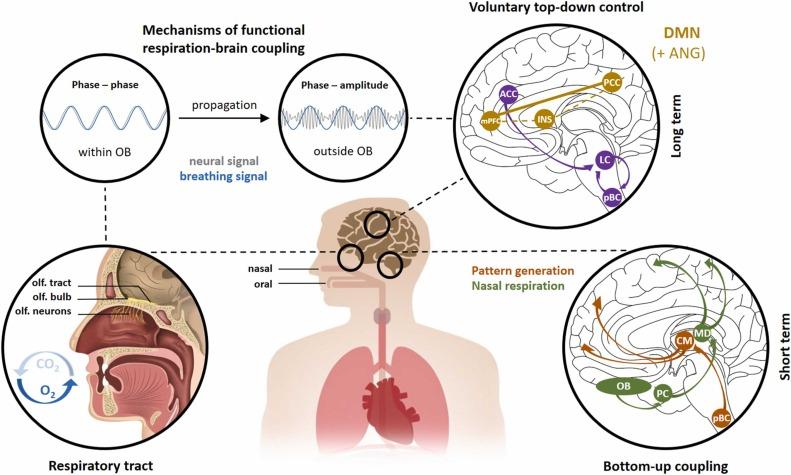


Fig.4. Respiration is coupled to neural oscillations and thus modulates brain activity. From left to right: During inspiration, air enters the respiratory tract through the mouth or the nose. In the case of nasal inspiration, the airflow triggers [mechanoreceptors](https://www.sciencedirect.com/topics/neuroscience/mechanoreceptor) connected to the [olfactory bulb](https://www.sciencedirect.com/topics/neuroscience/olfactory-bulb), thereby initiating infraslow neural oscillations closely coupled to the respiratory rhythm. Through cross-frequency phase-amplitude coupling these slow oscillations are then translated to higher-frequency oscillations and propagated to upstream areas within and beyond the [olfactory system](https://www.sciencedirect.com/topics/neuroscience/olfactory-system). Through cortico-pontine pathways connecting higher-level frontal sites with the locus coeruleus, respiratory pattern generators within the brainstem (such as the preBötzinger complex) are under voluntary control, rendering respiration unique amongst interoceptive signals. Top-down control can be exerted for long-term modulations of respiratory patterns, for example in yogic or meditative practice. On a shorter timescale, as outlined above, bottom-up modulations of neural signalling are implemented through functional coupling of oscillatory amplitudes to the respiratory phase. Medullary pattern generators like the preBötzinger complex project to cortical areas via the central medial thalamus and locus coeruleus whereas oscillatory activity from the [olfactory tract](https://www.sciencedirect.com/topics/neuroscience/olfactory-tract) is relayed to the [piriform cortex](https://www.sciencedirect.com/topics/neuroscience/piriform-cortex) and higher-order cortices through the medio-dorsal thalamus. [DMN](https://www.sciencedirect.com/topics/neuroscience/default-mode-network) = default mode network, ANG = angular cortex, ACC = anterior cingulate cortex, PCC = [posterior cingulate](https://www.sciencedirect.com/topics/neuroscience/posterior-cingulate) cortex, mPFC = medial prefrontal cortex, INS = [insular cortex](https://www.sciencedirect.com/topics/neuroscience/insular-cortex), LC = locus coeruleus, pBC = preBötzinger complex, OB = olfactory bulb, PC = piriform cortex, CM = centromedial thalamus, MD = mediodorsal thalamus.

Evidence from rodent and human studies suggest a two-stage mechanism underlying the respiratory influence on action, perception, and cognition: In a first step, respiration influences neuronal activity by driving infraslow neural oscillations within the olfactory system (e.g., olfactory bulb) that follow the respiratory rhythm (phase-phase coupling). In a second step, the phase of these oscillations modulate the power of [higher frequency oscillations](https://www.sciencedirect.com/topics/neuroscience/high-frequency-oscillations) (up to the gamma band) through cross-frequency phase-amplitude coupling. (51)

An important feature of olfactory perception is its dependence on respiratory activity. By inspiration olfactory information ascends directly to olfactory related limbic structures. Every breath with odor molecules activates the limbic areas associated with emotional experience and memeory retrieval.(52)

Inputs from higher centers in the cortex and limbic structures can disrupt respiratory timing and rhythm. These disruptions are the result of emotional and psychological states, such as fear and anxiety, which are known to influence breathing patterns independently of central and peripheral chemoreceptor input. Breathing is particularly sensitive to states of hyperarousal, during which signs of increased respiratory drive are evidence of the body‟s readiness for action.

Anticipation of coming physical and emotional events, that contain some element of threat, has the distinct effect of increasing respiratory rate, reducing time of exhalation and changing respiratory pattern. Fluoroscopic studies show that in situations of emotional stress, the diaphragm shows signs of hypertonicity becoming flattened and immobile . Individuals with psychological disorders can exhibit both inflexibility of breathing and excessive breathing irregularity. Trait anxiety is specifically characterised by a reduced flexibility and responsiveness of breathing associated with the wider pervasive reduction in behavioural and psychophysiological responsiveness and adaptability.

Inappropriate breathing patterns may be the result of conditioning by fear, anxiety and air hunger. Breathing habits such as thoracic breathing and excessive sighing, which are appropriate in particular circumstances, are dysfunctional when they persist as conditioned breathing habits that are inflexible and inappropriate (Disease processes in the respiratory and cardiovascular systems such as asthma, and heart failure can increase ventilatory needs, stimulate respiratory drive and alter respiratory control with resulting alterations in breathing patterns such as rapid shallow breathing, thoracic breathing and paradoxical breathing, which can be functional adaptations to respiratory and cardiovascular pathology but might also contribute to increased physical symptoms. Breathing pattern adaptations to organic disease become dysfunctional when complicated by changes in breathing behavior and perception brought about by psychological and behavioral factors

Breathing pattern abnormalities represent neuromuscular and biomechanical aspect of dysfunctional breathing. There are various types of breathing pattern disorders including disorders of respiratory muscle co-ordination, timing, stability and responsiveness. Breathing pattern disorders many contribute to problems of speech, posture, motor control and balance. They may aggravate symptoms of dyspnea and muscular skeletal pain. Habitual presence of breathing pattern dysfunctions, such as thoracic and paradoxical breathing, may impair the function of homeostatic reflexes originating from oscillating hemodynamic fluctuations

Breathing disturbances, may be indicative of a deeper core dysfunction i.e. inability to achieve physical and psychological states of rest, and functional breathing, needed for recovery of homeostasis. Disruption of autonomic nervous system function is a key feature of homeostatic dysregulation.In the early literature on battle fatigued soldiers, which formed the basis for later enquiry into dysfunctional breathing, mental and physical exhaustion resulting from prolonged hyperarousal were considered to be the cause of breathing and cardiovascular symptoms.

Functional breathing modulates arousal, balances autonomic nervous system function and promotes homeostasis. It can be argued that dysfunctional breathing is breathing that does not perform the autonomic nervous system and homeostatic regulating functions. Habitual presence of thoracic breathing, paradoxical breathing, hyperventilation or excessively irregular breathing might all indicate a general dysfunction of a person‟s ability to alternate the arousal state with periods of rest.

Three factors necessary for breathing to be effectively used for self regulation include:

1. Accurate perception;

2. The ability to experience breathing sensations as pleasant; and

3. Flexibility and responsiveness of breathing.

Poor perception of whether one‟s breathing is normal or obstructed and lack of sensitivity or hypersensitivity to sensations arising from breathing modulations are aspects of breathing dysfunction . Breathing sensations can be overperceived or underperceived with inaccurate perceptions of breathing sensations being caused by factors that disrupt other aspects of respiratory control. These causative factors include altered chemosensitivity, hyperinflation of the lungs , psychological factors such as anxiety and panic, and personality traits such as defensiveness and tendencies to attention deficit . Inaccurate perception of breathing may have implications for the use of breathing as a tool for self-regulation and for conditions associated with dysfunctional breathing such as asthma.

Attention to breathing sensations is an important part of meditation and relaxation techniques that aim to improve psychological, spiritual and physical health. Lack of breathing awareness and inaccurate perception of breathing sensations may have implications for breathing and meditation strategies that aim to increase mind-body connection by focus on the sensations of the breath Frequent experience of breathing as unpleasant or frightening may reinforce dysfunctions of breathing and also have an adverse influence on psychophysiological self-regulation and the function of affective neural circuitry.

Pleasurable sensations associated with the satisfaction of homeostatic needs, may enhance a person‟s ability to use breathing for relaxation and self-regulation with relaxing and salutogenic effects during breathing exercises . Several breathing therapies pay particular attention to directing sensory awareness and mental attention to the pleasant nature of breathing. Focus on the pleasant aspects of breathing sensations is emphasized in Buddhist meditation techniques that instruct the practitioner to pay attention to the “beautiful breath”

A key aspect of breathing functionality is its appropriateness and ability to adapt quickly to changing emotional and environmental conditions. This adaptability and responsiveness is influenced by a combination of psychological, physiological, neurological and muscular factors. Iindividuals who are unable to modify breathing patterns are inhibited in their abilities to apply breathing strategies for self-regulation. Lack of flexibility and responsiveness of breathing may also reduce an individual‟s sense of control and contribute to the negative affective components of dyspnea.Breathing is dependent on many factors, both physical and mental, that influence its rate, depth, and shape. Within psychophysiology, respiratory measures function mainly as dependent variables, reflecting the state of the individual. The individual may voluntary modify breathing patterns in order to change mental or physical tension states

The most common definition of breathing refers to the passage of air that serves for lung function and ventilation. Breathing is measured by way of lung function parameters such as rate, inhalation time, exhalation time, pauses, tidal volume, minute volume, flow (duty cycle), O2 saturation, and end-tidal CO2. Without air movement, there is no voice or sound, and the person cannot smell. The regulation of air passage to ensure speech and communication is highly complex and represents a different process from ventilation . The behavioral demands contingent on communication mostly overrule the ventilatory requirements.Breathing difficulties may signify difficulties in social interaction and experience rather than ventilatory problems.

A second definition refers to the rhythmic expansion and contraction of the body. This breathing motion brings the air in and out of the lungs as a central pump, or oscillator, in the body that moves various organs and the fluids; for example, it acts to move venous blood, lymph fluid, and the cerebrospinal fluid. In addition to these hydraulic effects throughout the body, there is a clear oscillatory relationship with heart rate and heart rate variability that affects the autonomic nervous system. The coordination of breathing movement determines the effort of the pump and affects movement and posture. The components of the breathing apparatus play a role in posture, weight bearing, walking, and lifting objects. The qualities that apply here are smoothness of movement, fluency, effortlessness, and coordination throughout the whole system, from head to feet.

A third definition of breathing refers to its role in self-perception. Like any movement, breathing is a sensory motor activity that serves to provide important feedback to the conscious individual about his or her state. The sense of freedom of movement or restriction in space, tension or relaxation within oneself, safety or danger within the environment, the quality of internal feedback provoke a person to feel free or restricted because of changes in self-perception.

An important aspect of breathing is, to what degree its sensation is accessible to conscious awareness. The lack of this awareness leads to disruption of the natural rhythm. Patients with lung disease can be “non perceivers,” which means that they do not notice changes in lung.Breathing is a vital process that functions automatically but can also be voluntarily controlled to reach specific goals, especially preventive and therapeutic ones. The voluntary control of breathing, particularly slowing down its rate, has been used for thousands of years as an essential part of most meditative and relaxation practices, stemming from Eastern traditions .Voluntary slow breathing (VSB) is used as a prevention technique to support physical and [mental health](https://www.sciencedirect.com/topics/psychology/mental-health), given it is suggested to influence the [parasympathetic nervous system](https://www.sciencedirect.com/topics/psychology/parasympathetic-nervous-system) (PNS).

Voluntary slow breathing is a technique where breathing is performed at a slower pace (around 6 cycles per minute, cpm) than spontaneous breathing, which is usually comprised between 12 and 20 cycles per minute in adults , and usually with a higher breathing amplitude . The benefits of voluntary slow breathing have been found at many levels of health and stress-related physiology, including optimizing the functioning of the autonomic nervous system (e.g., baroreflex, respiratory sinus arrhythmia), the functioning of cardiopulmonary and neuroendocrine functions, decreasing anxiety and arousal, and increasing relaxation and resilience . Regarding the physiological effects of voluntary slow breathing, effects on blood pressure have already received some attention showing modest reductions following voluntary slow breathing interventions.

List of Conditions for Which Breathing Therapy Has Been Applied Successfully

Tension-related problems without specific cause

• Feelings of tension

• Hyperventilation complaints

• Burnout

• Headache

• Chronic fatigue

• Sleeping problems

• Concentration problems

Psychological problems

• Anxiety and phobia

• Panic disorder

• Depression

Functional problems of musculoskeletal nature and breathing

• Lower back, shoulder, and neck complaints

• Shortness of breath

• Chronic pain (repetitive strain injury, whiplash, fibromyalgia)

• Functional voice disorders, dysphonia, stuttering

Tension problems with a specific, somatic cause

• Lung disease (asthma)

• Heart disease (myocardial infarction,arrhythmia, )

• Neurological disease (hemiplegia,Parkinson disease)

Heart rate increases during inhalation and decreases during exhalation in a respiratory cycle and this phenomenon is called respiratory sinus arrhythmia (RSA).Heart rate variability biofeedback (HRVBFB) or resonance breathing is breathing at a slow rate, usually 4.5 to 7 breaths per minute, which depends on each individual, to maximise their RSA. Self-training in resonance breathing lowers stress, blood pressure, and improves mood . Training on resonance breathing improves vagal tone, thereby improving HRV, which is an index of stress and health. Enhanced vagal tone improves cognitive abilities based on the neuro-visceral integration model. Resonance breathing reduces depression and anxiety through its vagal pathway, affecting the locus coeruleus, orbitofrontal cortex, amygdala, insula, and hippocampus .

During inhalation, the cardiovascular center inhibits vagal outflow resulting in speeding the HR. during exhalation, it restores vagal outflow resulting in slowing the HR *via* the release of acetylcholine.

During HRV biofeedback training, adults may be instructed to engage in paced abdominal breathing between 4.5 and 7.5 bpm guided by a real-time display of instantaneous HR and respiration.

During normal breathing , one of the many oscillations in heart rate occurs at the same frequency as breathing , but the amplitude of HRV is systematically related to breathing frequency with higher amplitudes achievable with slower respiration. People breathe at differing frequencies at different times and various individuals tend to breathe at different rates.

[Respiratory sinus arrhythmia](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/respiratory-sinus-arrhythmia) (RSA) or cardiac coherence refers to the fluctuation in heart rate during a breathing cycle, with an increase during inhalation and a subsequent decrease after exhalation. Paced breathing during the HRV [biofeedback](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biofeedback), involves intentional slow breathing to enhance RSA, usually at a pace of 4.5–7 breaths per minute (bpm). These techniques are recognized for their positive effects on well-being, stress reduction, and [blood pressure regulation](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/blood-pressure-regulation)  and can also induce changes in the [resting HRV](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/resting-heart-rate) and the [brain](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/protocerebrum) circuits that help control HRV and regulate emotion.

Resonance breathing, augments [vagal tone](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/vagal-tone), subsequently enhancing HRV as a health and stress index. The neuro-visceral integration model suggests that a heightened vagal tone can bolster cognitive functions, such as improved attention and brain functionality derived from paced breathing, [mindfulness](https://www.sciencedirect.com/topics/neuroscience/mindfulness) meditation, and aerobic exercise . Paced breathing at specific frequencies has been linked to reduced emotional distress, operating through the vagal pathway  and influencing HRV, with ascending and descending [breathing rates](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/breathing-rate) producing consistent results. Non-linear parameters, provide insight into the complex interactions between respiration, [cardiovascular function](https://www.sciencedirect.com/topics/medicine-and-dentistry/cardiovascular-physiology), and autonomic modulation. Research has indicated that increased RSA and elevated levels of HRV are linked to improved health results and extended lifespan while low RSA is linked to poorer health conditions, such as chronic stress, anxiety disorders, depression, [PTSD](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/posttraumatic-stress-disorder), and aging.

Focusing on both linear and non-linear aspects of HRV can offer a complete insight into cardiac [autonomic regulation](https://www.sciencedirect.com/topics/neuroscience/autonomic-regulation) while performing paced breathing techniques. RSA (or cardiac coherence), is the term used to describe the fluctuations in the heart rate that is characterized by a shortening of the R–R interval during inspiration and a prolongation during expiration. These changes are largely affected by the vagal tone and can be noticed within the frequency span of 0.15–0.4 Hz. A notable connection can be found between changes in the depth and timing of respiration and the amount, consistency, and timing of vagal cardiac output in individuals who are awake.

Noteworthy differences are evident when comparing values during natural breathing and controlled, rhythmic breathing. Under normal breathing conditions, the rhythmic alterations in vagal [motor neuron](https://www.sciencedirect.com/topics/medicine-and-dentistry/motoneuron) activity associated with respiration commence during the exhalation phase, develop gradually, and do not completely manifest themselves during fast breathing rates . Increased [tidal volumes](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/tidal-volume) and reduced respiration rates directly impact and elevate RSA by means of the central connection between the cardiac vagal [motor neurons](https://www.sciencedirect.com/topics/neuroscience/motor-neuron) and the respiratory drive. Relaxation and breathing techniques utilize awareness of breathing rate, rhythm, and volume. Most often breathing techniques are used to minimize physiologic responses to stress, possibly by increasing parasympathetic response in conjunction with relaxation techniques such as muscular relaxation and autogenic training. (51-58)

**EXERCISE THERAPY**

Therapeutic exercise involves long term adaptation upon the musculoskeletal, metabolic, cardiovascular, and respiratory systems to correct impairments, restore muscular and skeletal function and/or maintain a state of well-being. In the injured or ill individual, the benefits of exercise include recovery and restoration of function, including the range of motion, increased cardiopulmonary reserve, and functional status. The main measurement of exercise capacity is the lactate threshold and maximal oxygen uptake (know as VO2 max).The maximal oxygen uptake (VO max, L/minute) reflects the ability of a person to imbibe, transport, and use oxygen, which defines that person's functional aerobic capacity. This capacity, is the gold standard of cardiorespiratory fitness.  VO max (ml/kg/min) = 79.9 – (0.39 x age) – (13.7 x sex (0=male, 1=female) – (0.127 x height)

**Skeletal muscle metabolism** — Muscle contraction and relaxation depend primarily upon hydrolysis of ATP, which releases the chemical energy necessary for binding of the protein myosin with actin filaments to allow myosin to slide along the actin filament leading to mechanical contraction. Exercise has anti-inflammatory effects as well as nourishing the joints themselves through pushing more synovial fluid through the joint. Indications for therapeutic exercise are for recovery from illness, risk of fall , cardiopulmonary disorders and uncomplicated musculoskeletal disorders, including osteoarthritis, patellofemoral disorder,

Exacerbations of chronic disease can be detrimental to exercise capacity. Patients with acute arthritis flares are able to perform water and pool-based exercises that are low-impact on joints. Cardiac conditions that qualify for exclusion are valvular heart disease, ventricular hypertrophy, dangerous arrhythmias, and malignant hypertension. The great benefits imparted by exercise outweigh the small risks involved with increased activity

Therapeutic exercise mainly falls into three categories

1. Endurance training: Defined as the use of large muscle groups in the area of 50 to 60% VO2Max to achieve greater cardiovascular endurance.
2. Resistance training: This modality increases overall strength and comes in three forms: isotonic, isometric, and isokinetic. Isotonic consists of dynamic movements with a constant load. Isokinetic involves a constant velocity with variable load. Isometric involves static muscle contraction with no change in muscle length. All forms of resistance training have favorable effects on diabetes, osteoporosis, and cancer with increases in bone mineral density, increased bowel transit time, increased glucose uptake in muscle, and improvements in back pain.
3. Flexibility training: slowed, controlled exercises performed in a gradual manner in the range of motion at joints or series of joints. Three main types exist: static, dynamic, and PNF (proprioceptive neuromuscular facilitation).Static involves held effective positions with little required in terms of assistance and time. Dynamic involves repetitive bouncing movements that produce muscle stretch over time. PNF involves alternating contraction and relaxation of agonist/antagonist muscles at specific joints that generally produce the largest increase in flexibility.

All of these are combinable into exercise programs that work for many different types of patients. Different subtypes of modalities can help to increase effectiveness or allow participation of individuals with special needs based on comorbidities. One example would be aquatic therapy for stroke patients with balance difficulties.<https://www.ncbi.nlm.nih.gov/books/NBK555914/>

Basic exercise prescriptions should follow the FITT mnemonic.

* F- frequency: number of days per week
* I- Intensity: low, moderate or vigorous
* T- Time: minutes per session for endurance exercise
* T- Type: endurance, strength, flexibility or some combination

Exercise programs require individualization according to the age of the patient, severity of OA (osteoarthritis), and/or comorbid disease. The analytic exercises for improvement of muscle strength in hip OA aim to influence the hip abductors, adductors, flexors, and extensors. In knee osteoarthritis and pathology, the target muscle groups are thigh muscles such as the quadriceps muscle and posterior group of thigh muscles, calf muscles (triceps surae muscle), as well as hip joint muscles such as gluteus and sartorius.

Exercise is essential in diabetes prevention and management and has positive effects on glucose metabolism such as decreasing insulin resistance and free fatty acid in the bloodstream by reducing levels of obesity and increasing glucose transporter 4 (GLUT-4) content and transport, and insulin-stimulated limb blood flow and improving insulin sensitivity, Increased resistance training increases muscle mass, which in turn affects glucose uptake. Exercise slows peripheral neuropathy development by promoting endoneurial blood flow and greater oxygen delivery to nerves.

Therapeutic exercise has great potential to reduce pain and improve muscular strength, balance, and range of motion in individuals with osteoarthritis. Resistance and endurance training are especially beneficial for pain and balance with osteoarthritis in large joints such as the knee. The most validated is isokinetic exercise for the knee.While <https://www.ncbi.nlm.nih.gov/books/NBK555914/>for specific muscular and skeletal injuries, therapeutic exercises target at strengthening and rehabilitation to normal functioning, for pulmonary and cardiac disorders, offers a path to restoration and maintenance of function essential to the quality of life.

Physical activity is recommended by the US dept of health and human services for maintenance of function and continued health.

Persons aged 3 to 5 years: physically active throughout the day.

Persons 6 to 17 years: 60 minutes or more of moderate to vigorous activity per day.

Persons 18 to 65: 150 to 300 minutes of moderate aerobic physical activity or 75 to 150 min/week of vigorous activity or equivalent combination of these.

Persons 65 and older: multiple modalities of balance training, aerobic activity, and muscle-strengthening activity.

<https://www.ncbi.nlm.nih.gov/books/NBK555914/>The effectiveness of therapeutic exercise, exercise prescriptions, and physical therapy on musculoskeletal disorders, as well as cardiopulmonary disorders, diabetes, hypertension, and other chronic health problems, are well-established. Exercise has been described as one of the elements of the “healing power of nature,” along with diet, rest, fresh air, massage, and baths since the time of Hippocrates. Throughout the 20th century, the sociocultural shift from hard physical labor to sedentary living has been associated with both physical and mental health complications some of which are related to emotional stress . Numerous scientific studies have documented the association between habitual exercise and positive mood and affect.

Exercise therapy (also known as walk/talk therapy) is the practice of combining a program of exercise with traditional psychotherapy. Unique to psychotropic exercise therapy is the fact that walking is done during a counseling session under the guidance of an experienced exercise therapist. Exercise habits continue because of the inherent satisfaction (enjoying movement or play), in addition to the psychological benefits. Adding exercise to psychotherapy can be beneficial for people suffering from a wide variety of mental health issues and interpersonal problems, it has been described by some as the “neglected intervention For those under the age of 40 who do not have medical complications (neurological disorders, orthopedic limitations, back injuries, chest pain, or an endocrine disorder such as diabetes), a moderately intense, progressively increasing program of exercise is usually safe). Enjoyment of the activity is more important than the intensity.

A variety of different forms of exercise, including functional activities of daily living (ADL) such as walking, lifting, pushing, or climbing stairs, can be beneficial. Aerobic exercise (walking, jogging, bicycling, and/or swimming) of moderate intensity carried out for 30–60 minutes (at minimum) at least 3–5 days per week would be effective in altering mood and fitness levels. Anaerobic exercise (weight lifting and isometrics) that includes intense, short bouts of activity with an occasional valsalva maneuver (breath holding) effort can also be beneficial . A wide variety of enjoyable recreational or leisure activities, such as hiking, biking, snowshoeing, and cross-country skiing, are particularly effective when conducted in moderately adverse weather conditions, in part because of psychological hardiness and mood-enhancement side benefits that develop accordingly . In addition, the competitive games (e.g., basketball, racquetball, soccer, etc.) have also been shown to have positive benefits for mood and affect .

* + 1. Aerobic exercise: does not require any equipment.
    2. Strength exercise involves the use of weights.
    3. Mobility involves static and dynamic stretching. Time stretching does not count towards the recommended 150 minutes of exercise per week.

Exercise has been shown to increase heat and cold tolerance, thereby instilling a degree of physical and emotional hardiness and stability. When core temperature rises during and after moderate to intense exercise, a simultaneous reduction in muscle tension occurs . The physiological process of adapting to variations in core temperature also modulates emotions substantially. In addition, there is a reduction in gamma motor activity that accounts for the reductions in muscle tension and state anxiety following exercise and passive heating. Improvements in brain wave laterality are associated with a reduction in anxiety when core temperature increases after an intense exercise. Vigorous exercise (running, jumping, lifting, etc.) generates minor trauma to the tissues of the body, which in turn causes a release of endorphins and endocannabinoids. As a result, positive mood changes appear in the form of analgesia, sedation, anxiolysis, and a sense of well-being.

This outcome is particularly common when intense endurance training elevates resting plasma beta-endorphins and the enhanced sense of well-being among healthy middleaged men. A reduction in the stress reactivity effects and reduced sensitivity to pain are linked to higher levels of endorphins following exercise. Some exercise enthusiasts report the feeling of an “exercise high” following an intense workout. These euphoric sensations are likely associated with a surge in serum endorphin levels in the bloodstream and in the brain . The effects of endorphins is highly efficacious and specific mechanism associated with a positive sense of well-being and a relief from discomfort due to the effects of low- to high-intensity exercise, depending on individual specificity.

Exercise increases the sensitivity of serotonin receptors, making these naturally produced chemicals more potent in the process of reducing depression . The role of exercise in decreasing sympathetic and increasing parasympathetic activity is associated with simultaneous improvement in emotional stability. These exercise effects (reducing stress and enhancing relaxation) are efficacious and the hormonal changes can be replicated and validated. Muscle tension is the body's psychological response to anxiety-provoking thoughts and can be released by tensing and relaxing specific muscle groups.

Debilitating factors in sports where an athlete’s grip (e.g., golf, auto racing, gymnastics) or ball handling (e.g., basketball, football, baseball) is critical, as dexterity is compromised due to the reduced blood flow to extremities associated with increased sympathetic arousal. Negative emotions may cause attention to become either narrowed (resulting in hyperfocus on stimuli central to the task) or inefficient (consuming the resources available for the high working memory tasks required for highly skilled athletic movements). In addition, when emotion intensity increases to extreme levels, attentional narrowing may lead to distraction—the visual search wanders to threatening or irrelevant cues—and deterioration of performance and a greater risk of injury . Eventhough for many athletes, experiencing uncertainty, nervousness, or fear before and/or during competition is viewed as natural and potentially helpful to performance, if his/her coping resources are overwhelmed by the intensity or duration of negative emotion(s), stress occurs, triggering avoidance behaviors that are debilitating for athletic performance . Thus exercise therapeutical training should be a must as well for professional atlethes to ameliorate their performance. (59)

**MEDITATION**

Based on contemporary psychological theory, clinical application, and research to date, the following six domains are posited as heuristically useful in framing meditation effects: cognitive, physiological, emotional, behavioral, relation to self, relation to others, and spiritual. Meditation is fundamentally a cognitive process that involves learning to shift and focus the attention at will onto an object of choice, such as bodily feelings or an emotional experience, while disengaging from usual conditioned reactivity or elaborative processing. It is observed that constant reinforcement of happy thoughts is good for the well-being of both mental and physical health . Positive reviews positively impact the immune health by reducing interleukin six (IL-6) levels. Such changes at the biological level mean that the thoughts have effect on the physical system. One of the initial effects of meditation is acute awareness of the “monkey mind,” the continuous jumping of thought from one point to another.

The most basic instruction in meditation techniques elicits a sense of physical relaxation. Sitting quietly, letting the breath slow down, and disengaging the mind from active thinking generally leads to a sense of substantial relaxation. Meditation, through the process of disengaging reactive attention, influence the balance between sympathetic arousal and parasympathetic relaxation, slowing heart rate and decreasing blood pressure . This shift is essentially the “relaxation response”. Other peripheral physiological effects include changes in endocrine and immune system functioning Improved behavioral regulation in response to meditation practice may be the result of several factors: improving emotional regulation, slowing the chain of behavioral reactions as awareness is cultivated, increasing receptivity to behavioral and lifestyle recommendations, or learning to tolerate and “ride out” waves of craving rather than respond impulsively.

Initial effects include increased awareness of behavioral patterns, followed by decreases in impulsive and compulsive behavior. There may be a sense of general “deconditioning,” of being somehow “freed” from the power of earlier patterns of avoidance or compulsions. This sense of freedom may be accompanied by increases in purposeful, focused or “wise” action. The term meditation refers to a mental state or the continued thought or reflection or contemplation on sacred or solemn subjects. For many who are troubled by the stresses of modern life , people turn to for help in coping with anxiety and in finding a deeper meaning in life. Meditation practice is better conceptualized as a way of changing usual processes of attention, awareness, and cognition. These attentional skills enable one to disengage from or limit or suspend the habitual patterns of analytical reactivity , and then may facilitate the emergence of self-regulatory functions that are experienced as healthier, more balanced, or somehow “wiser,” in an enduring way, and reflective of sustained neurophysiological change.

Brain changes during meditation have been observed in numerous EEG and neuroimaging studies and there is some evidence for meditation effects on endocrine,neurotransmitter, and immune system measures.Meditation is aimed to reduce thoughts to ultimately reach the state of thoughtless awareness which is considered a different state of consciousness where one is fully perceptually alert, yet has no thoughts. It is consequently described as a state of pure attention without any thought content. This state of pure “contentless attention” appears to be subjectively associated with feelings of positive emotions and is described in Sanskrit as the state of “Sat Chit Ananda” which translates as a state of pure attention and joy.

It has been shown that long-term meditators have a diminished thalamic response to experimental pain stimuli compared with age-matched non-meditators. Meditation involves a state of altered consciousness and may increase alpha wave power in occipital, parietal and temporal brain regions, as well as gamma power, as measured by magnetoencephalography (MEG) and electroencephalography (EEG), respectively. Long-term meditation practices may also help preserve the brain’s regions, including the prefrontal cortex and right anterior insula .A considerable number of studies point to significant changes in physiological parameters, such as blood pressure and circulation, heart rate and variability, plasma triglycerides, total cholesterol and low-density lipoprotein (LDL) cholesterol, HDL cholesterol, skin temperature, lung functions (such as the increment in forced expiratory volume and a reduction in the number of exacerbations), relaxation state measured by electroencephalography, light emission measured by photon counting, electrical charge measured by gas discharge visualization, and electrical conductance. (60-61)



### Fig.5. Meditation and its effect on mental health.

**MANTRA MEDITATION**

Meditation encompasses a family of gentle practices that include mantra meditation (MM), mindfulness meditation, spiritual meditation, yoga, tai chi, chi gong, and others. Of these practices, MM is described as one of the simplest and the most effective nonjudgmental meditative practice for various health benefits or for spiritual inspiration . Concentration meditation entails directing attention on some inten tional process like the repetition of a word or phrase (mantra), or the breath.The term mantra originates from Sanskrit and means an instrument of mind or thought. It is a sacred utterance consisting of syllables, words, or verses to form a sacred symbol, spiritual figure, or magic incantation.

A mantra is a central feature in MM, which employs a repeated mantra as the focus of meditation to distinguish itself from other forms of meditation. MM is a range of techniques to achieve a meditative state by repeating a mantra, in which mantra repetition no longer consciously occurs and instead, the mind reaches a near-empty state without thought or bothering by anxiety or attachments.

The mantras adopted in MM are relatively short and can be only one syllable, such as “Om” or “Ham,” known as seed syllables. In general, mantras can be chanted silently, softly, or loudly with active or passive breathing. People have used meditation as a nonpharmacological strategy to foster positive mental and physical health among the general population for various health benefits in the areas, including anxiety, pain, depression, stress, and insomnia. During MM, the body and mind can enter a state of profound rest. Research has shown MM to be correlated with decreased blood pressure (BP) in both pharmacologically treated and untreated hypertensive meditators.

Mantra meditation is distinguished by the use of a repeated sound (mantra) as the focus of meditation. In this respect it differs from other meditation methods that direct the person’s attention to the breath or the contents of the mind or to contemplation of some other meditational object When the meditator’s attention wanders, he or she is directed to bring it back to this attentional object in an easy, unforcing manner The rising interest in these meditative techniques is because of the fact that they are related to the biofeedback techniques (which also emphasize a delicately attuned awareness of inner processes) and to muscle relaxation and visualization techniques used in the behavior therapies.

Technically, meditation can be classified as “concentrative” or “nonconcentrative” in nature. A concentrative technique limits stimulus input by directing attention to a single unchanging or repetitive stimulus (e.g., a mantra, a candle flame). The directives of mantra meditation are concentrative in nature. A nonconcentrative technique expands the meditator’s field of attention to include as much of his or her conscious mental activity as possible (e.g., the directives of mindfulness meditation are defined are nonconcentrative in nature). Repeating a sound mentally over and over again, as in mantra meditation, is a relatively simple act that requires little preparation to be executed successfully.

During mantra meditation, body and mind typically enter a state of profound rest. Oxygen consumption can be lowered during 20–30 minutes of meditation to a degree ordinarily reached only after 6–7 hours of sleep and the electroencephalogram (EEG) shows an alert–drowsy pattern with high alpha and occasional theta wave patterns, as well as an unusual pattern of swift shifts from alpha to slower (more sleep-like) frequencies and then back again. Meditation may be an unusual fluid state of consciousness, partaking of qualities of both sleep and wakefulness, and possibly resembling the hypnogogic or “falling asleep” state more than any other state of consciousness. A number of studies have shown that the physiology of meditation differs from that of ordinary rest with eyes closed .

This dual process—free-flowing thoughts occurring simultaneously with a repetitive stimulus that induces a state of calm—sets up a subjective state in which deep relaxation is paired with a rapid, self-initiated review of an exceedingly wide variety of mental contents and areas of tension, both verbal and nonverbal. As thoughts, images, sensations, and amorphous impressions drift through the mind during meditation, the soothing effect of the mantra appears to neutralize the disturbing thoughts. If awareness of any sort is restricted to one unchanging source of stimulation, then consciousness of the external world may be turned off or greatly attenuated, and the individual may achieve a form of mental blank-out. Then mantra meditation continuously recycling the same input over and over, may result in a blank-out effect, which may temporarily clear the mind of all thoughts. The after effect of blank-out may be an opening up of awareness and a renewed sensitivity to stimuli.

In the unaccustomed quiet of the meditative state, one’s own breathing may be intimately sensed, the pulse rate may be perceived, and even such subtle sensations as the flow of blood through the veins are sometimes described as emerging into awareness. The rhythmic component of mantra meditation may be a major factor in inducing calm using bodily rhythms as their object of focus. Rhythm has been used as a natural tranquilizer; using repeated sounds or rhythmic movements to quiet agitated infants, for example.

Parents rock children gently, repeated affectionate sounds, or bounce the children rhythmically on their laps, with an intuitive awareness of the soothing effects of such rhythmic activities on the children’s moods . During mantra meditation a greater equalization in the workload of the two cerebral hemispheres may occur, in which verbal, linear, time-linked thinking (processed through the left hemisphere in the right-handed person) are lessened .Mantra meditation may be indicated when a tendency toward self-blame is excessive or when irrational blame of others has become a problem. (62).

**MINDFULLNESS MEDITATION**

Although all meditation techniques cultivate the ability to focus and manage attention, mindfulness meditation primarily cultivates an ability to bring a nonjudgmental sustained awareness to the object of attention rather than cultivating focused awareness of a single object, such as a word or mantra, as occurs in concentrative meditation. All meditative approaches combine elements of both concentrative and mindfulness practice, but for therapeutic purposes, there are important differences in technique and application. In mindfulness meditation, attention is purposefully kept broader, utilizing a more open and fluid focus but without engaging analytical thought or analysis. Mindfulness meditation may utilize any object of attention—whether an emotion, the breath, a physical feeling, an image, or an external object—such that there is more flexibility in the object of awareness than there is in concentrative meditation and such that the object may shift from moment to moment.

Mindfulness meditation can affect the stress response in four separate stages:

First, provides a way to free the senses from whatever is pulling at them.

Second, to observe patterns of responding or reacting, as they occur.

Third, to react and respond to the sense objects gradually disengage and weaken.

Finally, allows more integrative, “wiser,” or distinct levels of processing to emerge, contributing to more effective responses.

Mindfulness meditation facilitates metacognitive processing, in which thoughts are observed as “just thoughts” . In mindfulness or insight meditation, cultivating “bare attention” is one of the most powerful aspects of meditation practice for individuals whose conscious minds are habitually caught up in thoughts and in reactions to those thoughts. Unlike concentrative techniques, mindfulness meditation is not designed to “block out” conscious thinking but rather to cultivate the ability to relate to conscious awareness in a nonreactive way. Whereas concentrative approaches may be more effective in producing trance-like states, mindfulness meditation is more effective in cultivating an ability to maintain awareness of experience without engaging habitual reactions to such experience.

The mind is designed to construct meaning out of experience. The constructed meaning is encapsulated by conscious thoughts . Compulsions and obsessions such as in eating disorders or addictions are powerfully directed by constructed thoughts and conditioned reactions, which the individual experiences both as uncontrollable and as an integral aspect of “self.” Conditioned desires distort perception, create an illusionary sense of self, produce craving and attachment, are the primary source of distress. The goal is to disengage the identity of the “self” from the content of one’s thought. Eating behavior and food choices are particularly responsive to mindfulness practice . Mindfulness-Based Eating Awareness Therapy (MB-EAT) use guided meditations that focus explicitly on cultivating awareness of hunger signals, satiety signals, and triggers for eating. In addition to guided meditations focused on eating behavior and emotional triggers for overeating, other meditation practices include the body scan, chair yoga, and walking meditation to increase comfort with the body, and forgiveness meditation and wisdom meditation to address negative self-judgment and to heighten a sense of meaning and purpose.Anger management may be particularly well suited to mindfulness meditation approaches in that awareness, acceptance, and the ability to suspend immediate reaction are core to disengaging anger responses. Mindfulness-Based Cognitive Therapy (MBCT) specifically address the downward spiral of negative thinking and emotion that contribute to relapse in clinical depression.

Mindfulness meditation is characterized by cultivating the ability to “fall awake”, inducing trance states, accessing hidden memories, or creating dissociative experiences .Through the process of mindfulness, one is able to disidentify from the contents of consciousness (i.e., one’s thoughts) and view his or her moment-by-moment experience with greater clarity and objectivity.

Reperceiving can be described as a rotation in consciousness in which what was previously “subject” becomes “object.” This shift (making what was subject, object) has been heralded as key to development and growth across the lifespan . Reperceiving is inthis sense a metamechanism underlying mindfulness, the practice of which is simply a continuation of the naturally occurring human developmental process whereby one gains an increasing capacity for objectivity about one’s own internal experience. Intentionally cultivating nonjudgmental attention leads to connection, self-regulation and ultimately health.

Reperceiving help people recognize what is meaningful for them and what they truly value as conditioned by family, culture, and society. Instead of just observing, we become the value itself. We are pushed and pulled by what we believe (based on cultural or familial conditioning) but fail to reflect upon truly important in the context of our own lives. When we are able to separate from (observe) our values and reflect upon them with greater objectivity, we have the opportunity to rediscover and choose values that may be truer for us. In other words, we become able to reflectively choose what has been previously reflexively adopted or conditioned. Automatic processing limits considerations of options that would be more congruent with needs and values. An open, intentional awareness help us choose behaviors that are congruent with our needs. When subjects are “acting mindfully,” as assessed by the Mindful Attention Awareness Scale (MAAS) state measure, individuals act in ways that are more congruent with their actual values and interests.

Reperceiving facilitates more adaptive, flexible responding to the environment in contrast to the more rigid, reflexive patterns of reactivity that result from being overly identified with one’s current experience and the capacity to observe one’s mental commentary about the experiences encountered in life. It enables the development of the capacity to observe our ever-changing inner experience and see more clearly our mental-emotional content, which in turn fosters greater cognitive-behavioral flexibility and less automaticity or reactivity and affords a different place from which to view the present situation as it is in this moment to respond accordingly, instead of with reactionary thoughts, emotions and behaviors triggered by prior habit, conditioning, and experience. If we are able to see a situation and our own internal reactions to it with greater clarity, we will be able to respond with greater freedom of choice (i.e., in less conditioned, automatic ways). Mindfulness interventions aim to foster greater attention to and awareness of present moment experience.

Reperceiving—the capacity to dispassionately observe or witness the contents of one’s consciousness—enables a person to experience very strong emotions with greater objectivity and less reactivity. This capacity serves as a counter to the habitual tendency to avoid or deny difficult emotional states. Through this direct exposure, one learns that his or her emotions, thoughts, or body sensations are not so overwhelming or frightening. Through mindfully attending to negative emotional states, one learns experientially and phenomenologically that such emotions need not to be feared or avoided and that they eventually pass away . This experience eventually leads to the “extinction of fear responses and avoidance behaviors previously elicited by these stimuli” .

Mindfulness has been operationalized in many different ways in the scientific literature . Two features appear in most definitions of mindfulness. First, mindfulness grounds attention and awareness in one’s present moment experience. The present moment experience that one attends to can take many forms, including one’s body sensations, emotional reactions, mental images, mental talk, and perceptual experiences (e.g., sounds). Scholars have described this monitoring feature of mindfulness as “watchfulness” or a “lucid awareness of each experience that presents itself ”. Second, many contemporary conceptualizations of mindfulness posit that adopting an attitude of openness or acceptance toward one’s experience is critical. This open and accepting attitude consists of attending to experience with a curious, detached, and nonreactive orientation. This attitude of acceptance toward experience is not one of passive resignation to one’s current circumstances but rather one of inviting in experiences, even if they are difficult.

Formal mindfulness training practices focus on training multiple features of attention, such as noticing when the mind wanders, repeatedly reorienting attention back to a focus area (e.g., sensations of breathing), developing sustained attention, and learning how to foster an open accepting form of attention so as not to get caught up in thoughts, emotions, or body sensations. Mindfulness interventions not only train attention but also develop the skill of maintaining an open and accepting attitude toward experience, which may be important for emotion regulation and affective outcomes.

Mindfulness interventions foster an ability to more objectively observe one’s moment-tomoment experience, and this decentered mindset (also described as metacognitive awareness or nonattachment) may be an important psychological mechanism of change. Decentering involves observing internal experiences from a more objective third-person stance , which may help one more effectively decide how he/she wants to respond to thoughts, emotions, or behaviors .

Participants in mindfulness interventions may report various unpleasant reactions, such as agitation, anxiety, discomfort, or confusion, during formal mindfulness training exercises (although participants also commonly report relaxation and contentment). These negative reactions are viewed as an important feature of the psychotherapeutic change process in mindfulness interventions because sustained mindful attention to one’s experience is thought to help participants explore and understand the full embodied experience of these reactions, to learn that the experience of these reactions is temporary, and to foster insight into how one reacts to these uncomfortable experiences.

A participant who has a life history of trauma might experience the resurfacing of these trauma memories during mindfulness training exercises, potentially triggering a major depressive episode. Individuals who are at risk for psychosis (e.g., schizophrenia) or seizures (e.g., epilepsy) might put themselves at elevated risk for exacerbation of these symptoms if they participate in formal mindfulness exercises . In addition to short-term depleting effects, it is also possible that the cognitive demands of adopting more reflective awareness of one’s present moment experience might disrupt, slow, or bias one’s responses on cognitive tasks. Mindfulness meditation integrated with cognitive therapy has become popular to improve outcomes in the treatment of depression .

Mindfulness meditation involves the cultivation of moment-to-moment, nonjudgmental awareness of one’s present experience, whether narrowly or more broadly focused. The goal of these practices is to cultivate and develop stable attention and nonjudgmental and nonreactive awareness of one’s internal (e.g., cognitive–affective–sensory) and external (social–environmental) experiences including physical relaxation, emotional balance, behavioral regulation, and changes in self-judgment, self-awareness, and relationship to others.The popular component of many mind–body therapies such as mindfulness, is to bring the mind to the present moment in a non-judgmental way. The state of being married and marital satisfaction are associated with adaptive immune responses, where poorer marital quality,disruption, conflict, stress and hostile marital interactions are related to maladaptive alterations in cardiovascular activity, increased catecholamine levels with depressive symptomatology and dysregulation of systemic immune function. While there are various meditation styles, all types of meditation practices incorporate self observation of mental activity, attentional focus training, and cultivating an attitude that high lights process rather than content, the central element of mindfulness is to acquire attentional control by focusing on events generated internally (bodily sensations, breath, thoughts, emotions) and externally (sights, sounds) at the current moment with nonjudgmental acceptance. Mindfulness meditation has been formalized for clinical interventions with Mind fulness Based Stress Reduction and Mindfulness Based Cognitive Therapy. (63)

**QIGONG and TAI-CHI**

Qigong is more ancient in origin than Tai Chi and original discipline incorporating widely diverse practices designed to cultivate functional integrity and the enhancement of the life essence that the Chinese call Qi. Both Qigong and Tai Chi sessions incorporate a wide range of physical movements, including slow, meditative, flowing, dance-like motions. In addition, they both can include sitting or standing meditation postures as well as either gentle or vigorous body shaking and incorporate the purposeful regulation of both breath and mind coordinated with the regulation of the body.

Qigong and Tai Chi are both based on theoretical principles that are inherent to traditional Chinese medicine (TCM).[https://pmc.ncbi.nlm.nih.gov/articles/PMC3085832/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3085832/#R1) In the ancient teachings of health-oriented Qigong and Tai Chi, the instructions for attaining the state of enhanced Qi capacity and function point to the purposeful coordination of body, breath and mind : “Mind the body and the breath, and then clear the mind to distill the Heavenly elixir within.” This combination of self-awareness with self-correction of the posture and movement of the body, the flow of breath, and stilling of the mind, comprise a state which activates the natural self-regulatory (self-healing) capacity, stimulating the balanced release of endogenous neurohormones and a wide array of natural health recovery mechanisms which are evoked by the intentful integration of body and mind.

Qigong translates from Chinese to mean to cultivate or enhance the inherent functional (energetic) essence of the human being and is considered to be the contemporary offspring of some of the most ancient healing and medical practices of Asia. Earliest forms of Qigong make up one of the historic roots of contemporary Traditional Chinese Medicine (TCM) theory and practice.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3085832/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3085832/#R2) Many branches of Qigong have a health and medical focus and have been refined for well over 5000 years.

Qigong allows individuals to cultivate the natural force or energy (“Qi”) in TCM that is associated with physiological and psychological functionality. Qi is the conceptual foundation of TCM in acupuncture, herbal medicine and Chinese physical therapy and the ubiquitous resource of nature that sustains human well-being and assists in healing disease as well as having fundamental influence on all life and even the orderly function of celestial mechanics and the laws of physics.

Qigong exercises consist of a series of orchestrated practices including body posture/movement, breath practice, and meditation, all designed to enhance Qi function (that is, drawing upon natural forces to optimize and balance energy within) through the attainment of deeply focused and relaxed states. From the perspective of Western thought and science, Qigong practices activate naturally occurring physiological and psychological mechanisms of self-repair and health recovery. Both internal Qigong (personal practice) and external Qigong (clinician emitted Qi) are seen as affecting the balance and flow of energy and enhancing functionality in the body and the mind.

There are thousands of forms of Qigong practice that have developed in different regions of China during various historic periods and that have been created by many specific teachers and schools. While some of these forms were designed for general health enhancement purposes and some for specific TCM diagnostic categories, some others were originally developed as rituals for spiritual practice, and others to empower greater skill in the martial arts.

A dozen forms that relate to health outcomes are Guo-lin, ChunDoSunBup, Vitality or Bu Zheng Qigong, Eight Brocade, Medical Qigong.The internal Qigong practices in health research incorporate a range of simple movements (repeated and often flowing in nature), or postures (standing or sitting) and include a focused state of relaxed awareness and a variety of breathing techniques that accompany the movements or postures. A key underlying philosophy of the practice is that any form of Qigong has an effect on the cultivation of balance and harmony of Qi, positively influencing the human energy complex (Qi channels/pathways) which functions as a holistic, coherent and mutually interactive system.

**Tai Chi**

Tai Chi translates to mean, “Grand Ultimate” in the Chinese culture, and represents an expansive philosophical and theoretical notion which describes the natural world in the spontaneous state of dynamic balance between mutually interactive phenomena including the balance of light and dark, movement and stillness, waves and particles. Tai Chi, the exercise, is named and has been originally developed both as a martial art (Tai Chi Chuan or taijiquan) and as a form of meditative movement. The practice of Tai Chi as meditative movement is expected to elicit functional balance internally for healing, stress neutralization, longevity, and personal tranquility.

For numerous, complex sociological and political reasons,[https://pmc.ncbi.nlm.nih.gov/articles/PMC3085832/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3085832/#R2) Tai Chi has become one of the best known forms of exercise or practice for refining Qi and is purported to enhance physiological and psychological function. The one factor that appears to differentiate Tai Chi from Qigong is that traditional Tai Chi is typically performed as a highly choreographed, lengthy, and complex series of movements, while health enhancement Qigong is typically a simpler, easy to learn, more repetitive practice. Even the longer forms of Tai Chi incorporate many movements that are similar to Qigong exercises. The more complex Tai Chi routines include Qigong exercises as a warm-up, and emphasize the same basic principles for practice, the three regulations of body focus, breath focus and mind focus. Therefore Qigong and Tai Chi, in the health promotion and wellness context, are operationally equivalent.

The Tai Chi used in both disease prevention and as a complement to medical intervention is a “modified” Tai Chi (e.g., Tai Chi Easy, Tai Chi Chih, or “short forms” that greatly reduce the number of movements to be learned). The modifications generally simplify the practice, making the movements more like most health oriented Qigong exercises that are simple and repetitive, rather than a lengthy choreographed series of Tai Chi movements that take much longer to learn and delay the experience of “settling” into the relaxation response. A partial list of examples of modified Tai Chi forms are: balance exercises inspired by Tai Chi, Tai Chi for arthritis, 5 movements from Sun Tai Chi, Tai Chi Six Form, Yang Eight Form Easy, and Yang Five Core Movements.

A compelling body of research emerges when Tai Chi studies and the growing body of Qigong studies are combined. Qigong (pronounced “chi kung”) is a general term for a variety of traditional Chinese energy exercises and healing practices. The word Qigong is a combination of two Chinese ideograms: qi, meaning “vital energy,” and gong, meaning “skill,” “work,” and “achievement.” So Qigong refers to integrated mind–body exercise for mastering vital energy, or cultivation of vital energy. Like acupuncture, herbal medicine, massage, and cupping, Qigong forms an integral component of traditional Chinese medicine.

Traditional Chinese medicine (TCM) posits the existence of a subtle energy (qi) circulating throughout the entire human mind and body. When it is strengthened or balanced, it can improve health and ward off or slow down the progress of disease. The concept of bioenergy can also be found in other cultures, such as ki in Japan, prana in India, and mana in Hawaii and the Philippines. There are more than 1,000 registered Qigong schools or forms in contemporary China, and many more have existed throughout history. As a result, there is no consistent definition of Qigong within the Qigong or health communities.

According to the textbook used in colleges of Chinese medicine, Qigong is a self-training technique or process that integrates the body posture, breathing, and mentality into oneness to achieve the optimal state for both body and mind .Qigong is the key component of TCM, and has a history longer than that of Chinese medicine itself. Qigong has existed as a term for a long time, but it did not become popular until the 1950s, when scientists and doctors started researching its effectiveness in health maintenance. At that time, Qigong gained public acceptance over other traditional and more abstruse terms such as daoyin (“conduction”), tuina (“taking out the stale energy and putting in the fresh energy”), yangxiou (“health maintenance and cultivation”), Xiounian (“cultivation and practice”), and Yangsheng (“health maintenance and improvement”). References to Qigong can be found throughout more than 3,000 years’ worth of written records.

There have been numerous forms and schools of Qigong in Chinese history. Various methods can be used to classify these Qigong forms. Although Qigong was well known for its healing and health potential, most forms of Qigong were not created for the purpose of healing but for the cultivation of mind and spirituality. Currently, the Chinese government classifies all contemporary Qigong into two categories—preventive health Qigong and medical Qigong—ignoring its spiritual tradition.

Historically, Qigong can be divided into five major disciplines or traditions: Confucianist, Buddhist, Taoist, medical, and martial arts. Each discipline has its own set of goals, methods, and forms. Confucianist Qigong, developed by the followers of Confucius, is designed for the attainment of higher moral character and intelligence, focusing on education and moral cultivation. This form of meditation reflects one of the essences of Qigong, an exercise of consciousness. Typical forms in this tradition are “listening to breathing” (a meditation form with a focus on slow breathing and attention to listening to the breathing) and the “sitting and forgetting self” exercise (a meditation form similar to mindfulness with an empty mind as the optimal goal.

Buddhist Qigong aims to liberate the mind by emphasizing the cultivation of virtue and enlightening wisdom, and considers the human body to be just a “stinking bag” holding the honorable spirit (claiming 58,000 schools or forms in history, and it is the most popular). With this philosophy, a pure Buddhist Qigong form is not concerned with much reason to building a healthy body. Health and healing are a side effect of developing a positive mind and relaxation state. The famous Buddhist Qigong traditions include Zen, Mi (Tibetan), and Tiantai.

Daoist (or Taoist) Qigong emphasizes the preservation of the physical body first, and then the higher levels of virtue and spiritual cultivation (3,600 schools have taught this form throughout history). Most Daoist Qigong consisted of training both the body (qi, or “ming” = life) and the spirit (yi, or “xing” = spirituality). Some encouraged body, or qi, cultivation before spiritual, or yi, cultivation, whereas others considered spiritual training more important than body training. Because Daoism put emphasis on the current life and has explored the techniques of preserving long life, since many Daoist Qigong masters have lived extremely long lives.

Biographies of Daoist Qigong masters throughout history show that most of them lived to be more than 90 years old in times in which the average life expectancy was around 40 . The famous Daoist Qigong traditions include Taiji, Danding (including Nei Dan Qigong), Jianxian (Sward Qigong), Fulu (fu implies “symbol”), Xuanzeng, and others. Medical Qigong forms have been created or practiced for healing of self or others and emphasizes how to use human vital energy (qi) to help eliminate imbalances and disharmonies, which are considered the root causes of many illnesses and diseases, and how to prevent them. It was influenced greatly by Daoist philosophy.

Historically, the most famous TCM doctors were also good Qigong practitioners. Medical Qigong teaches medical practitioners how to use the inner qi in a dynamic way for diagnosis, healing, and preventing diseases . Today, medical Qigong is still a standard course in many schools of Chinese medicine. The typical medical Qigong forms include Five-Animal-Acts Qigong (by Hua Tuo), Six-Healing-Sounds Qigong , Brighten-Eye Qigong, and Taiji Five-Element Qigong .

Martial Arts Qigong train the practitioner for self-defense, protecting and preparing the body to better endure sword cuts or sharp weapons or attacks by a powerful punch or kick. Such methods include Iron Shirt and Golden-Bell Qigong and train the body to deliver powerful blows that are enhanced with qi, such as the Burning-Palm or Iron-Palm methods. Many martial-art Qigong practitioners have died prematurely due to overexertion of their bodies or to an imbalance of inner qi. For example, Bruce Lee, a well-known contemporary martial-art Qigong practitioner, died in his mid-30s. All forms of Qigong are not the same and it is very important for a beginner to know which Qigong form is most appropriate for him or her.

Most Qigong practice involve a combination of such elements as relaxation, breathing work, guided imagery, slow movement, biofeedback, tranquil state, mindfulness meditation and mind–body integration. Qigong practice is said to help relax and develop a balance between the body, mind, and spirit, and relaxation.According to TCM, good health is a result of a free-flowing, well-balanced qi (energy) system, whereas sickness or the experience of pain is the result of qi blockage or unbalanced energy in the body.

Acupuncture and Qigong share the same qi flow and meridian theory. The meridian system charts the major channels of qi flow. The difference between acupuncture and Qigong is that acupuncture uses external force (needles or pressure stimulation) to help the qi flow and balance, whereas Qigong uses mostly internal force (qi cultivation and self-practice) to help smooth the qi flow and break the qi blockages. In addition to the concept of qi, the concept of yi (mind or intention) also plays a key role in Qigong practice and Qigong healing. TCM believes that qi tends to follow the yi (“qi shui yi xing”).

When a person is under stress or is disturbed by many random thoughts for a long time, his or her qi cannot flow smoothly or normally, and he or she will soon experience qi imbalance (emotional disturbance) or qi blockage (psychosomatic symptoms). Therefore, having the consciousness focus on one thing or on nothing (mindfulness) is the key to training in Qigong practice. This focus creates a state of empty mind without desire. Cultivation of the mind can be practiced at any time without Qigong or meditation.

Medical Qigong refers to the Qigong forms or therapies used by medical practitioners who emphasize using vital energy (qi) to assist with diagnosis and to control and prevent illness and disease. Medical Qigong, or Qigong therapy, consists of both internal Qigong exercise (self-practice) and external qi healing (through the clinician’s involvement). Although Qigong is a self-training method, the emission of qi (or external Qigong therapy) has always been part of the medical Qigong practice that attempts to help others regain their health, similar to the practice of reiki in Japan and of therapeutic touch in the United States.

Internal Qigong training is the major component of medical Qigong and refers to the self-practice of Qigong forms. There are three major categories of these Qigong forms for stimulating a balanced qi flow and a tranquil state: movement (active) Qigong (dong gong), “standing pole” (zhuang gong) Qigong, and static forms or meditation (jing gong). Movement Qigong (an introductory form) uses guided physical movements or gestures to help practitioners concentrate and induce the qi energy flow in the body. Earlier forms of taiji quan may be considered as typical movement Qigong.

Static Qigong is meditation, which includes relaxation, breathing manipulation, mindful meditation, guided imagery, incantation, seal palm symbols, and mindfulness state. The main purpose of static Qigong is the training of intentional power, or consciousness stability, when cultivating qi energy. The intention or consciousness, once well-trained, will lead qi flow in the body, direct it to where it is needed, and break through the blocked area. Blocked qi is considered to be the origin of many illnesses and diseases.

The “standing pole” is a form between movement and static Qigong, which starts with a standing position. Then, as the qi is cultivated or moved, various spontaneous movements will follow. The magnitude or degree of the movement varies, and may even be greater than during movement Qigong. External Qigong therapy (EQT) refers to the process by which a Qigong practitioner directs or emits his qi to help break qi blockages in others and induce the sick qi out of the body so as to relieve pain or to balance the qi flow in the body and get rid of disease. EQT can be practiced through the use of either qi (emitting vital energy) or yi (the consciousness or intentional therapy) or a combination of the two techniques (the type most commonly used).

Meditation is one of the most important components in Qigong practice. In some sense, all meditations could be called Qigong in China, but internal practice of medical Qigong is more than meditation. In order to differentiate medical Qigong from other meditation forms, medical Qigong is thought to work toward health and healing from a TCM perspective. In terms of practice, most meditations involve a single practice or focus, for example, concentration on one’s breathing. Standing meditation, accompanied by spontaneous movement, is actually a powerful means of qi generation and qi balance by nature.

Qi plays an important role in medical Qigong practice .Qigong uses the qi-flow meridian theory. One of the healing mechanisms of Qigong, from a TCM perspective, is the belief that motivated qi (vital energy moving more powerfully after Qigong practice) strikes against areas of illness in the body and removes destructive blocks to allow healthy qi to flow. There is experiential evidence that Qigong practitioners may clearly feel pain or soreness during practice as a result of this qi-striking process.

Although most meditation requires the role of mind or intention, medical Qigong meditation puts the role of yi (mind and intention) above anything else in two distinct ways:

(1) the induced state of “empty mind without desire” and emphasis on tranquility helps a practitioner to calm conflicting emotions and resolve mental disturbances,

(2) the resulting tranquil state strengthens a practitioner’s power of intention. The qi meditation to treat stress engages these components through a guided imagery process. In addition to the relaxation response common to other types of meditation, medical Qigong meditation generates healing results by rapidly uncovering the body’s selfhealing potential through modulated breathing, liberated tranquility, intentional qi induction, guided imagery, and an enhanced mind–body communication. The increased immune functions that are facilitated by these processes result in a strengthened self-repair and self-regeneration capability.

Three common types of responses occur during intensive Qigong practice that have been mislabeled as potential side effects or reported as “Qigong deviations” in the literature:

1. Appearance of new symptoms or increased severity of old symptoms. This is typical for medical Qigong practice when qi strikes against a location of illness or a blocked area. TCM practitioners believe that sickness or experience of pain is the result of qi blockage or unbalanced energy in the body. One mechanism of Qigong therapy for pain relief and symptom reduction is motivating qi and energy within the body, breaking the qi blockage and balancing the energy system. A person with a history of arthritis of the knee might feel increased pain at the knee for a period of time after intensive Qigong practice. If he/she stops practicing at that moment, the pain will continue for a while; if he/she continues practicing Qigong, the qi strikes against the blockage (arthritis), and the pain will completely disappear forever.

2. Pain or soreness through the back and neck area. Some practitioners may even feel as though they have the pressure of a mountain on their heads. This occurs when strengthened qi starts flowing upward in the Du meridian (along the spinal cord) and strikes through the “Jiaji gateway” and the “Yuzeng gateway” in the lower back and at the back of the neck, the common qi striking points. Under close supervision and with proper understanding, the practitioner can easily correct this problem by continuing practice and getting over the blockage and can reach a higher level of cultivation. Many psychiatrists who do not practice Qigong may consider this a psychosomatic symptom due to Qigong practice.

3. Hallucinations and Qigong psychoses. It is common for the advanced Qigong practitioner to experience some hallucinations or illusions during Qigong practice, such as photism or phonism. As long as the practitioners do not believe what they see or hear or sustain these hallucinations, and as long as they continue their practice, these hallucinations will eventually go away. There is no danger of becoming disoriented so long as the practitioner knows in advance that this might happen. Practicing with a misunderstanding of Qigong hallucinations or practicing with strong intentions or inappropriate purposes (such as to communicate with higher beings, to develop supernatural ability, or to reach self-completion, as some sham Qigong practitioners advocate), may lead to various forms of psychosis or even to schizophrenia or other types of abnormal behaviors.

Most of the so-called side effects of Qigong practice may simply arise from the natural pathways of qi cultivation, and can be overcome by continuous practice. The key in dealing with these issues is for the practitioner to be informed in advance, not to believe in what appears during practice, and to continue practicing Qigong until the stage is over.

Tai chi and qigong, traditional Chinese medicine techniques incorporate body movement, breath, and attentional training to improve disease symptoms and maintain health The practice of tai chi includes slow body positions that flow from one to the next continuously and that promote posture, flexibility, relaxation, well-being, and mental concentration. The main difference between qigong and tai chi is that tai chi is a martial art and practiced quickly and they are externally focused and provide self-defense . Qigong is internally focused. A similar technique from a Western context is “therapeutic eurythmy.” Some evidence has revealed that short-term Tai Chi practice induces changes in frontal activations during task switching and long-term Tai Chi practice induced stronger frontostriatal FC during a decision-making task embedded with emotional components.(64-66)

**YOGA**

Among many mind and body practices, mind–body exercise (i.e., Tai Chi, qigong and yoga) is a specific type of practice that incorporates meditation into the execution of movement routines to improve body balance and the flexibility and strength of the musculoskeletal structures[https://www.nature.com/articles/s41598-023-37309-4](https://www.nature.com/articles/s41598-023-37309-4#ref-CR3).Yoga is an ancient Indian, non-religious mind–body approach that has components centering on meditation, mindfulness, breathing, and activity or postures. In its earliest form, yoga was a practical discipline incorporating techniques whose goal was the development of a state of mental and physical health, well-being, inner harmony, and, ultimately, an experience involving “a union of the human individual with the universal and transcendent Existence”.

It can be considered not a religious practice but a form of practical mysticism, the primary goal of which is the ultimate manifestation or achievement of the unitive experience that has been described with terms such as cosmic, universal, transcendental consciousness, oneness, or bliss. Yoga practices are believed to have originated in early civilizations on the Indian subcontinent, and they have been practiced historically in India and throughout East Asia and have evolved distinctly separately from Oriental religions.While yoga may be ben eficial for some diseases, certain forms are likely contraindicated in neurologic disorders. For example, Bikram yoga, which is practiced in very hot temperatures, is likely risky for patients with multiple sclerosis. Physiologically, yoga practice is noted to produce changes in heart rate, blood pressure, galvanic skin response, respiratory rate, fasting blood glucose (Type II diabetes mellitus and healthy), breath holding time, auditory and visual reaction times, and intraocular pressure.Literally yoga is the unification of jibatma with paramatma. It integrates our body, mind and thought process. This in return controls our life style, reduces stress and makes one free from diseases.

The integral yoga plays a vital role in total transformation among physical, mental and spiritual. Both short-term and long-term yoga practice induce changes in brain changes in the frontoparietal areas when participants perform various afective tasks. Regarding changes in task-based FC, long-term yoga practice strengthens FC within the frontoparietal network during the color Stroop task. During working memory tasks, FC is strengthened between the PFC and various brain regions, including the parietal brain areas, cerebellum and insula, while it is reduced within parietal brain areas, cerebellum and insula. (67-68)

**COGNITIVE BEHAVIORAL THERAPY**

Cognitive therapy is well known for emphasizing the identification of dysfunctional cognitions and for using a variety of interventions to modify those cognitions or minimize their impact. These interventions can be quite useful when dysfunctional cognitions play a role in the individual’s problems with stress. Cognitive restructuring and reality testing often are an important part of cognitive therapy. The techniques of cognitive modification are aimed at improving a patient’s way of processing information and, consequently, his or her grasp of reality.

The term cognitive-behavioral therapy (CBT) refers to interventions aimed at altering a patient’s thoughts, behaviors, or emotional responses to assist in recognizing and controlling response to symptoms using a programmed education or counseling approach and involves relaxation or guided imagery, in which the patient uses his or her imagination to create mental images that distract attention away from symptoms.

It has been found to be effective in a large number of outcome studies for psychiatric disorders including depression, anxiety disorders, eating disorders, substance abuse, and personality disorders and as an adjunctive treatment to medication for serious mental disorders such as bipolar disorder and schizophrenia. Its efficacy has been established also in the treatment of non-psychiatric disorders such as irritable bowel syndrome, chronic fatigue syndrome, fibromyalgia, insomnia, migraines, and other chronic pain conditions.

**Origins of Cognitive Behavior Therapy**

The idea for developing this form of psychotherapy took root when Aaron Beck began to notice that his patients with depression often verbalized thoughts that were lacking in validity and noted characteristic “cognitive distortions” in their thinking. His empirical observations led him to start viewing depression not as a mood disorder but as a cognitive disorder. Based on his clinical observations and empirical findings, Beck outlined a new cognitive theory of depression. He published *Cognitive Therapy for Depression*  after having published a study that evaluated and demonstrated the efficacy of cognitive therapy. As behavioral strategies were incorporated, the term cognitive therapy changed to cognitive behavior therapy by time.

**Cognitive Model**

CBT is based on a straightforward, common-sense model of the relationships among cognition, emotion, and behavior. Three aspects of cognition are emphasized:

**Automatic Thoughts**

An individual’s immediate, unpremeditated interpretations of events are referred to as automatic thoughts, that shape both the individual’s emotions and their actions in response to events. CBT is based on the observation that dysfunctional automatic thoughts that are exaggerated, distorted, mistaken, or unrealistic in other ways, play a significant role in psychopathology.

**Cognitive Distortions**

Errors in logic are quite prevalent in patients with psychological disorders. They lead individuals to erroneous conclusions. Below are some cognitive distortions that are commonly seen in individuals with psychopathology:

* Dichotomous thinking: Things are seen regarding two mutually exclusive categories with no shades of gray in between.
* Overgeneralization: Taking isolated cases and using them to make wide generalizations.
* Selective abstraction: Focusing exclusively on certain, usually negative or upsetting, aspects of something while ignoring the rest.
* Disqualifying the positive: Positive experiences that conflict with the individual’s negative views are discounted.
* Mind reading: Assuming the thoughts and intentions of others.
* Fortune telling: Predicting how things will turn out before they happen.
* Minimization: Positive characteristics or experiences are treated as real but insignificant.
* Catastrophizing: Focusing on the worst possible outcome, however unlikely, or thinking that a situation is unbearable or impossible when it is just uncomfortable.
* Emotional reasoning: Making decisions and arguments based on how you feel rather than objective reality.
* “Should” statements: Concentrating on what you think “should” or “ought to be” rather than the actual situation you are faced with or having rigid rules which you always apply no matter the circumstances.
* Personalization, blame, or attribution: Assuming you are completely or directly responsible for a negative outcome. When applied to others consistently, the blame is the distortion.

**Underlying Beliefs**

Underlying beliefs shape the perception and interpretation of events. Belief systems or schemas take shape through life experiences. They are defined as templates or rules for information processing that underlie the most superficial layer of automatic thoughts. Beliefs are understood at two levels in CBT:

*Core Beliefs*

* The central ideas about self and the world
* The most fundamental level of belief
* They are global, rigid, and overgeneralized

Examples of dysfunctional core beliefs:

* “I am unlovable”
* “I am inadequate”
* “The world is a hostile and dangerous place”

*Intermediate Beliefs*

* Consist of assumptions, attitudes, and rules
* Influenced in their development by the core beliefs

Examples of dysfunctional intermediate beliefs:

* “To be accepted, I should always please others.”
* “I should be excellent at everything I do to be considered adequate.”
* “It is best to have as little as possible to do with people.”

**Clinical Significance**

Cognitive behavior therapy is a structured, didactic, and goal-oriented form of therapy. The approach is hands-on and practical wherein the therapist and patient work in a collaborative manner with the goal of modifying patterns of thinking and behavior to bring about a beneficial change in the patient's mood and way of living his/her life. It is used to help a wide range of problems, and appropriate treatment protocols are applied depending on the diagnosis and problems the patient is facing. Most psychotherapists who practice CBT personalize and customize the therapy to the specific needs of each patient.

The first step is an assessment of the patient and the initiation of developing an individualized conceptualization of him/her. The conceptualization based on the CBT model is built from session to session and shared with the patient at an appropriate time later in therapy. The approach to therapy is explained very early at the start of the therapy. The problems patient would like to work on in therapy, and goals for therapy are decided in the first or second session collaboratively. The prioritized problems are worked on first.

The structure of each session:

The session always starts with a brief update and check on mood. This is followed by bridging from the previous session to establish continuity. The agenda of what will be talked about in the session is set up collaboratively, and the homework the patient had to do between the sessions is reviewed before plunging into talking about any problem. Issues on the agenda are talked about punctuated with feedback and summaries. The session ends with setting up further homework and a final summary.

Examples of CBT in practice:

Anxiety: CBT often focuses on replacing negative automatic thoughts that can occur in generalized anxiety disorder. In treating panic disorder, CBT may include desensitization to triggers that provoke anxiety; it is important to note,that a potential adverse effect of this technique is a temporary mild increase in anxiety.

Depression:  In patients who are no longer taking part in activities that typically bring them pleasure, CBT may initially focus on reinitiating positive activities to overcome inertia.

Attention deficit hyperactivity disorder (ADHD): Behavioral therapy is the initial recommended treatment for children younger than 6 years old. Behavioral treatments are also recommended for older children, especially if they have a poor response or adverse effects on medication. Behavioral therapy interventions include parent training and behavioral classroom management with a focus on setting clear rules and expectations for the child with appropriate rewards and punishments and daily feedback.

Panic attack with sudden, unexpected, episodic bursts of anxiety is characterized by autonomic symptoms (e.g., sweating, hyperventilation, palpitation, light-headedness) and fear of impending doom. Frequent complications include anticipatory anxiety, which is the almost constant fear of panic attacks; agoraphobia, or phobic avoidance of situations associated with panic attacks; and secondary demoralization, occasionally leading to severe depression. Once the attacks are blocked, the anticipatory anxiety, agoraphobia, and depression usually remit, as well.

Patients with social phobia (social anxiety disorder [SAD] in DSM-IV) experience significant anxiety, usually coupled with alarming autonomic symptoms (palpitation, sweating, shortness of breath, chest pain, etc.), in one or more social situations. Their fear of embarrassing or humiliating themselves in these situations usually leads to significant avoidance. Limited social phobia involves one or two situations (e.g., public speaking). Patients with generalized social phobia are anxious in and tend to avoid many different social situations. Social phobia appears to be a chronic condition, beginning in late adolescence and often resulting in lifelong disability.

Patients experiencing repetitive senseless thoughts or impulses (obsessions), accompanied by repetitive and also senseless behaviors (compulsions) such as washing, counting, or checking or reexperiencing persistently a life-threatening traumatic event including flashbacks to the trauma, nightmares, “psychic numbness,” and affective symptoms, in addition to anxiety and symptoms of increased arousal develop a chronic illness. CBT is a valid and proven form of psychological therapy for a range of mental health disorders

The cognitive–motivational–relational theory (CMRT) defines emotion, as a psychophysiological reaction to environmental or social variables, consisting of internal subjective experience, impulses for action, and physiological change driven by individual cognitive appraisal of motivational and relational variables that are mediating factors arousing, sustaining, modifying, or extinguishing the stress response. Coping plays a vital role in the stress process, since coping resources affect how an individual appraises a situation, and determine what emotion is displayed, how one responds to the psychophysiological symptoms of the aroused negative emotion, and whether stress occurs.

When present stimuli are consciously or unconsciously associated with past losses or potential harm , a threat appraisal is generated, negative emotion aroused, and the coping process is activated . When adequate coping resources are available, the perceived threat and negative emotion is minimized, and the individual is typically able to adapt. If the individual does not possess adequate coping resources, then stress and maladaptive behavior will be the results. Emotion research from general psychology suggests that the primary function of negative emotion such as fear or anxiety, is to mobilize the mind and body in preparation to avoid or approach threatening stimuli.

The specific psychophysiological effects of stress and negative emotion may include increased heart rate, blood pressure, and electrodermal response; disruption in respiratory sinus arrhythmia; decreased skin temperature (less peripheral blood flow); the release of potent damaging hormones; and reduced brain functioning, especially related to attention .

Cognitive behavioral theory suggests that emotions are derived from thoughts, therefore, if intrusive thoughts can be managed, the emotional consequence is more manageable.

Psychosocial interventions, such as cognitive-behavioral stress management (CBSM)

1. Produced positive effect on the quality of life of chronic disease patients

2. Influence the disease prognose in a positive way

3. Reduce distress of chronic pain patients and increase their physical activity to return to work

4. Reduce perceived stress and negative mood and overuse of medications and utilization of health care system.

5. İncrease social support,

6. İmprove problem-focused coping,

7. Affect cognitive appraisals . (69)

M**USIC THERAPY**

A number of studies have demonstrated that music listening and even more so music production, activates a multitude of brain structures involved in cognitive, sensorimotor, and emotional processing and music, itself engages sensory processes, attention, memory-related processes, perception-action mediation (“mirror neuron system” activity), multisensory integration, activity changes in core areas of emotional processing, processing of musical syntax and musical meaning, and social cognition. Then, the engagement of these processes by music have beneficial effects on the psychological and physiological health of individuals.

Music therapy have improving effects on the psychological and physiological health of individuals:

**1. Attention modulation:** Music can automatically capture attention or distract attention from stimuli prone to evoke negative experiences such as pain, anxiety, worry, sadness, etc. Music has pain-reducing effects as well as beneficial effects in the treatment of tinnitus or attentiondeficit disorders.

2. **Emotion modulation**: Studies using functional neuroimaging have shown that music can modulate activity of all major limbic- and paralimbic brain structures, that are crucially involved in the initiation, generation, maintenance, termination, and modulation of emotions and has implications for the treatment of affective disorders, such as depression, pathologic anxiety, and post-traumatic stress disorder (PTSD) because these disorders are related to dysfunction of limbic structures, such as the amygdala, and paralimbic structures, and the orbitofrontal cortex and emotions always have effects on the vegetative or autonomic nervous system, the hormonal (endocrine) system, and the immune system.

3. **Cognition modulation**: This factor includes memory processes related to music such as encoding, storage, and decoding of musical information, and of events associated with musical experiences, as well as processes related to the analysis of musical syntax and musical meaning. This factor might contribute to the effects of music therapy on the facilitation of Alzheimer’s patients’ adaptation to residing in a longterm care facility.

4. **Behavior modulation**: This factor accounts for the evocation and conditioning of behavior such as movement patterns involved in walking, speaking, grasping, etc. with music. The distinction between cognition (factor 3) and action (factor 4) should be understood conceptually, rather than physiologically, or even functionally, because cognition and action share a common neural code. For example, mirror neurons are active during both perception and action, auditory working memory (WM) relies on sensorimotor codes that encode and maintain information, syntactic processing of music involves brain structures also involved in speech production, and the premotor cortex serves a variety of cognitive tasks, such as WM, sequencing, and serial prediction. Cognitive processes, which are affected by the modulation of behaviors and actions, can be modulated by the learning of different or new behavioral and action patterns. A similar relation exists between actions and emotions.

5. **Communication modulation:** Music is a means of communication. Active music therapy in which patients make music, can be used to train skills of nonverbal communication. Music therapy has been applied for the treatment of communication disorders, such as selective mutism, and for the training of interpersonal competencies. This factor is related to social cognition: listening to music produced by other humans engages cognitive processes attempting to understand the intentions, desires, and perhaps even beliefs of those who produced the music. This effect could be used for the treatment of individuals with autism or conduct disorders.

6. **Perception modulation** : Another factor that contributes to the effects of music therapy is perception modulation. Musical training shapes the decoding of acoustic features, such as pitch height, and frequency modulations already at the level of the brain stem, as well as on the level of the auditory cortex. This suggests that musical training has effects on basic perceptual processes during language comprehension and can help in the treatment of language impairment impairment.

The activity changes in the anterior hippocampal formation evoked by listening to music are relevant for music therapy because patients with depression or PTSD show a volume reduction of the hippocampal formation associated with a loss of hippocampal neurons, and blockage of neurogenesis in the hippocampus and positive emotionality show reduced activity changes in the hippocampus in response to music.

Music therapy can reanimate activity in the hippocampus, prevent the death of hippocampal neurons, and lift the blockage of hippocampal neurogenesis. Another limbic structure that a number of functional neuroimaging studies reported to be activated during listening to pleasant, or positive, music is the NAc, which is part of the ventral striatum representations.Other cognitive functions in which the premotor cortex is involved comprise the analysis, recognition, and prediction of sequential auditory information, and the processing of musical structure or musical syntax.

The use of music to treat health problems is firmly rooted in history. The close association between music and medicine can be traced to ancient cultures, in which music was closely allied with medical practice . The oldest account of medical practices, the Kahum Papyrus, details the use of incantations for healing purposes.

Although the use of music to treat various psychological and physiological problems extends throughout antiquity, the Middle Ages, and the Renaissance, its modern history began at the end of the 19th century. This period marked the advent of empirical studies on physiological and psychological responses to music. These studies pointed to the effects of music on neurosis ; insomnia and fevers ; and blood pressure, circulation, cardiac contraction, and respiration .

Early researchers concluded that physiological functions responded reflexively to music and the individual’s appreciation for the music was the important determinant of physiological response . Music therapy as a formalized discipline has been established to affect health since immediately following World War II, when its effects on convalescing and “shell-shocked” patients were noted.

TABLE 1. Examples of Clinical Conditions for Which Music Therapy Is Used

• Developmental disabilities (Gfeller, 1999;Jellison, 2000)

• Physical disabilities (Thaut, 1999)

• Medical conditions (Dileo, 1999a; Dileo &Bradt, 2005; Standley, 2000)

• Behavior disturbances (Montello & Coons,1998; Rickson & Watkins, 2003)

• Offenders (Thaut, 1989)

• Stress (Dileo & Bradt, 2005; Pelletier, 2004)

• Sensory impairments (Codding, 2000; Robb,2003)

• Autism (Gold & Wigram, 2003; Thaut, 1992)

• Gerontology and Alzheimer’s disease (Clair,1996; Koger, Chapin, & Brotons, 1999)

• Psychiatric conditions(Silverman, 2003;Unkefer & Thaut, 2002; Maratos & Gold,2003; Gold, Bentley, & Wigram, 2003)

• Terminal illness (Dileo & Loewy, 2005;Hilliard, 2003)

The full range of possible experiences used in music therapy include :

(1) listening to live, improvised, or prerecorded music, or listening to and also “feeling” low-frequency music vibrations,

(2) performing music or learning/practicing on an instrument,

(3) improvising music spontaneously using voice and/or instruments,

(4) composing music (music and/or lyrics), and

(5) music combined with other arts modalities (e.g., art, dance, drama).

Music medicine refers to the use of music by medical or health care professionals to affect changes in various domains (physical, psychological, etc.). In this practice, taped music is used to elicit desired clinical effects or to enhance other types of treatment. Specifically, music alone is used as the intervention. Music listening is known to yield therapeutic benefits for self-help purposes and achieving relaxation.Music therapy–based stress reduction approaches are contraindicated in some psychiatric diagnoses, such as borderline personality disorder and autism because relaxed or altered states of consciousness may exacerbate the illness. Hearing difficulties may benefit from low-frequency music stimulation therapy listening.

The vibroacoustic or vibrotactile therapy requires low-frequency sound tones that provide direct stimulation to the body to be “vibrated.” Frequencies can produce “waves” of vibration throughout , various areas of the body, either by superimposing on the music or through other means. Precomposed and/or improvised music can be used in facilitating imagery experiences leading to relaxation. Research suggests that music enhances imagery vividness. The writings of Aristotle and Plato suggest that music was an important part of education, as well as religious and civil life, in ancient times. Currently, music therapy (MT) is recognized as the “clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program”. Interventions have been designed to promote wellness, manage stress, alleviate pain, express feelings, enhance memory, improve com munication, and promote physical rehabilitation . (70-72)

**HYPNOSIS**

During his medical practice in Vienna and Paris , Franz Anton Mesmer (1734–1815) defined hypnosis as an agreement between a person designated as the health-care hypnotist and a person designated as the patient to participate in a psychotherapeutic technique in which the hypnotist provides suggestions for changes in sensation, perception, cognition, affect, mood, or behavior . As a qualified physician, he thought that there was an invisible force, the animal magnetic fluid, that he could accumulate in his own body, then transmit to ill people and thereby restore them to health. Hypnosis has documented efficacy in a variety of conditions such as mental health disorders, smoking cessation, obesity, pain reduction, anxiety, and nausea and vomiting .

Hypnosis can be seen as ‘a waking state of awareness, or consciousness, in which a person’s attention is detached from his or her immediate environment and absorbed by inner experiences such as feelings, cognition and imagery’. Hypnotic induction involves focusing of attention and imaginative involvement to feel real. By the use and acceptance of suggestions, the clinician and patient construct a hypnotic reality.

Hypnosis could be seen as a meditative state, which one can learn to access consciously and deliberately, for a therapeutic purpose. Suggestions are then given either verbally or using imagery, directed at the desired outcome. This might allay anxiety by accessing calmness and relaxation, help manage side effects of medications, or help ease pain or other symptoms. Depending on the suggestions given, hypnosis is usually a relaxing experience, which can be very useful with a patient who is tense or anxious. However, the main usefulness of the hypnotic state is the increased effectiveness of suggestion and access to mind/body links or unconscious processing. Hypnosis can not only be used to reduce emotional distress but also may have a direct effect on the patient’s experience of pain. Hypnosis in itself is not a therapy, but it can be a tool that facilitates the delivery of therapy in the same way as a syringe delivers drugs. Hypnosis can help patients believe and experience what might be possible for them to achieve.

The brain has two cerebral hemispheres, and while in the normal waking state, the left brain tends to be more dominant and could be likened to the ‘conscious mind’. This communicates verbally and is more intellectual, conscious and rational part. When we relax or become deeply involved in some activity, the right brain, which is the more emotional, and creative part that communicates with symbols and images, as the ‘unconscious mind’, becomes more dominant . Neuroimaging research has demonstrated that subjective changes in response to suggestion are associated with corresponding changes in brain regions related to the specific psychological function in question. When someone imagines something in hypnosis (colour, sound, physical activity and pain), recent neuroscience findings show that similar areas of the brain are activated as when the person has that experience in reality.

When patients are highly anxious, they are operating at an emotional, rather than cognitive level, and one can engage and direct their creative imagination towards what is useful for them. Anxious patients are using their imagination to create possible catastrophic scenarios, which generate even more anxiety and which can then spiral into panic. Patients may feel that they are being overwhelmed by their emotions, but if the health professionals can engage their attention, direct their imagination to feeling calm or to re-experience some positive past experience or activity and give positive suggestions, then the patients will start to feel calmer and more able to cope. To enter hypnosis, one needs to focus attention (this is done during a hypnotic induction). While a candle flame could be a visual focus, music, chanting or using mantras could be an auditory focus. Induction could be mainly kinaesthetic, such as in progressive muscular relaxation (PMR) or could use ‘involuntary’ (or ideomotor) movement.

One of the simplest methods is to engage the patient’s imagination using revivification (or re-experiencing) of an experience, a daydream or fantasy. Hypnosis can be used formally in a therapeutic session or informally in conversation by directing the patient’s focus and engaging their imagination. Patients can then be taught self-hypnosis, which means they can enter this state deliberately at will, to utilise imagery and suggestion to help themselves. There is increasing evidence for the usefulness and cost-effectiveness of using hypnosis in a wide variety of conditions.

Hypnosis involves attention and focused concentration with a relative suspension of peripheral awareness. There are three aspects of hypnosis: absorption, dissociation, and suggestibility. Absorption is the tendency to become fully involved in a perceptual and imaginative experience.

Dissociation is the mental sep aration of experiential components that would ordinarily be processed together. Suggestibility is the heightened responsiveness to social cues lead ing to an enhanced compliance with hypnotic in structions. The brain changes associated with hypnosis have been documented by fMRI and EEG studies. (73).

**ART THERAPY** (AT)

Through creating art and reflect ing on the art products and processes, people can increase awareness of self and others; cope with symptoms, stress, and traumatic experi ences; enhance cognitive abilities; and enjoy the life-affirming pleasures of making art” . Art therapy (AT) , which is a non pharmacological medical complementary and alternative therapy, has been used as one of medical interventions with good clinical effects on mental disorders. New to the AT arena is mindfulness-based art therapy (MBAT) in hopes of improving symptom control, and processing information.

Art therapy, is defined by the British Association of Art Therapists as: “a form of psychotherapy that uses art media as its primary mode of expression and communication and by The American Art Association as “an integrative mental health and human services profession that enriches the lives of individuals, families, and communities through active art-making, creative process, applied psychological theory, and human experience within a psycho-therapeutic relationship” and has gradually become a well-known form of spiritual support and complementary therapy.

The American Art Therapy Association describes its main functions as improving cognitive and sensorimotor functions, fostering self-esteem and self-awareness, cultivating emotional resilience, promoting insight, enhancing social skills, reducing and resolving conflicts and distress, and promoting societal and ecological changes. The art therapist’s primary concern is not to make an esthetic or diagnostic assessment, but the overall goal is to change and grow on a personal level through the use of artistic materials in a safe and convenient environment.

Art therapists utilize many different art materials (i.e. visual art, painting, drawing, music, dance, drama and writing). Among them, drawings and paintings have been the most useful part of therapeutic processes within neurological, psychiatric and psychological specialities as well as medical based scientific audiences. Main contents of painting and drawing include blind drawing, spiral drawing, drawing moods and self portraits. Other srt forms fall under the prevue of their own professions (e.g. music therapy, dance/movement therapy, and drama therapy. ). The development of art therapy comes from the artisitc expression of the belief in unspoken things. AT may be defined as the application of artistic expressions and images to physically ill individuals, mainly cancer, autism, depression and anxiety, dementia and cognitive impairment, mental disorders patients, who are reluctant to express themselves in words. AT facilitates engagement when direct verbal interaction becomes difficult and provides safe and indirect way to connect oneself with others.Art painting therapy permits patients to express themselves in a manner acceptable to the inside and outside culture.

AT, as a non verbal psychotherapy method, does not only serve as an auxillary tool for diagnosing diseases to obtain hidden information that is difficult to gain from conventional tests, to judge the severity and progression of diseases and to understand patients’ psychological state from painting characteristics, but also as a useful therapeutic method helps patients to open up and share their feelings, views and experiences. Besides, the implementation of art therapy is easily accepted by patients without being limited to age, language, diseases nor environment and enhance communication between patients and on site medical staffs in a non verbal way and can be combined with other forms of therapy such as music and dance. The medium for painting bears potential messes, requires more cleaning and storing and drying space for paints and toxicity of allergens in the paint.

AT should be directed in the following ways in the future:

* 1. More high quality clinical trials are needed to gain more reliable and rigorous evidence.
  2. The evaluation methods for the effectiveness of AT should include not only subjective scales but also objective means such as brain imaging and biochemical examinations.
  3. The details of AT should be specifically explained to the patients for objective comparisons of the type of disease, painting methods, and theoretical and mechanism of the therapeutical method at the neurological, cellular, and molecular levels.
  4. Guidelines about art therapy should beformed on the basis of accumulated evidence.

Art therapy has been recognized as beneficial and effective since first described and studied by Adrian Hill’s published work in 1942 as the first person to use the term *Art Therapy*. Many of his art works that he painted from the front lines as an official war during World War I, are displayed in the Imperial War Museum in London. Hill personally discovered the therapeutic quality of art making when he was recovering from tuberculosis himself in 1938, and recorded his ideas in 1945 in *Art versus Illness*. He was employed as the first official art therapist in 1946 by the Netherene, a state psychiatric hospital in the United Kingdom and became later the president of the British Association of Art Therapists.

Art, one of the earliest forms of communication dating back to the cave art of the Paleolithic age, has been utilized for moral reinforcement and psychoanalysis. Art therapy has been increasingly recognized as beneficial and effective in the treatment of a broad range of both mental and physical conditions in both pediatric and adult scenarios such as treatment of traumatic brain injury, schizophrenia, sexual abuse, breast cancer, post-traumatic stress disorder, as well as numerous other conditions t enhances communication, and bolster self-esteem. Adolescents who experience abuse, low self-esteem, depression, or any other psychological issue tend to withdraw from their parental figures. Art therapy is a way for these troubled adolescents to feel expressive in a non-judgmental environment.[https://pmc.ncbi.nlm.nih.gov/articles/PMC4253394/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4253394/#ref7)

Art therapy is also important for the children to enhance the young patient’s emotional, physical, and cognitive development especially within the field of pediatric oncology, where restoring self image is crucial to continue battling against their illness. Art therapy can provide some end-of-life care for patients and their family before death. In adult oncology, art therapy has been used to help survivors to find their identity past their *survivor* label. Art therapy has been used in hemodialysis, HIV/AIDS, Alzheimer’s, and traumatic brain injury, schizophrenia, bipolar disorder, borderline personality disorder, trauma from sexual abuse, dementia, and many other conditions to find lasting benefits from art therapy.  (74).

**RELAXATION THERAPY**

The use of relaxation therapy dates back to the early 1900s and was popularized with the printing of The Relaxation Response in 1975. Relaxation therapies are measures designed to produce a state of relative freedom from mental and/or physical tension and to minimize sympathetic nervous system response, which in turn decreases oxygen demand, slows heart rate, and lowers blood pressure. Relaxation therapies may incorporate a variety of techniques such as deep breathing, guided imagery, progressive relaxation, meditation, yoga, hypnosis, and bio feedback.

**Box Breathing**

While there are many different forms of deep breathing exercises, box breathing can be particularly helpful with relaxation. Box breathing is a breathing exercise to assist patients with stress management and can be implemented before, during, and/or after stressful experiences. Box breathing uses four simple steps. Its title is intended to help the patient visualize a box with four equal sides as they perform the exercise. This exercise can be implemented in a variety of circumstances and does not require a calm environment to be effective.

**Guided Imagery**

Guided imagery is a relaxation exercise intended to assist patients with visualizing a calming environment. Visualization of tranquil settings assists patients with managing stress via distraction from intrusive thoughts. Imagery employs all five senses to create a deeper sense of relaxation. Guided imagery can be practiced individually or with the support of a narrator.

**Progressive Muscle Relaxation**

Progressive Muscle Relaxation (PMR) is a relaxation technique targeting the symptom of tension associated with anxiety. The exercise involves tensing and releasing muscles, progressing throughout the body, with the focus on the release of the muscle as the relaxation phase. Progressive muscle relaxation can be practiced individually or with the support of a narrator.

These techniques can be expanded to include diverse environments as complementary therapies to treat stress, anxiety, depression, and pain. In addition to its psychological impact, stress can cause physiological responses such as increased heart rate, palpitations, diaphoresis, shortness of breath, and muscle tension. Relaxation techniques can aid in the reduction of these unpleasant responses.

Relaxation techniques are therapeutic exercises designed to assist individuals by decreasing tension and anxiety, physically and psychologically. Relaxation therapy has been a a hallmark component of psychotherapy for ages. They can be utilized throughout healthcare environments as complementary therapies to treat patients experiencing various types of distress, including but not limited to anxiety, depression, pain, and stress<https://www.ncbi.nlm.nih.gov/books/NBK513238/>.

Relaxation techniques encompass an array of strategies used as therapeutic interventions for patients experiencing stress to increase feelings of calm and decrease feelings of stress. Feelings of stress can include physiological responses such as increased heart rate, shortness of breath, and muscle tension, along with the subjective emotional experience; and relaxation techniques can aid in the reduction of these symptoms. It is widely accepted that high stress, particularly sustained rates of high stress, have negative effects on physical and mental health. Chronic stress in childhood and adulthood can lead to increased blood pressure and mental health issues among other health concern. Additionally, chronic stress has been shown to affect brain development, specifically the amygdala which is essential for emotion regulation and the pre-frontal cortex which is necessary for executive functioning and decision-making. (75)

**AROMATHERAPY**

The medicinal use of plants can be traced back to the prehistoric age; interestingly. The term aromatherapy was coined by chemist René-Maurice Gattefossé in 1930 in Lyon, France. “Arom therapy is the controlled and skilled use of essential oils (volatile byproducts of plant metabolism) to maintain health and well-being and to prevent imbalances and illness on the physical, emotional, mental, and spiritual levels, for the good of mankind and preservation of the entire planet” . Essential oils have a variety of properties and they; are administered in a number of ways ; and depending on the oil, have the ability to calm, excite, or balance the individual.

Table2 . Aromatherapy: Methods of Application

Topical: Very few essential oils are appropriate for neat (direct) application to skin; therefore, most require dilution prior to application.

Massage, ointments, emulsions, and gels are commonly used.

Inhalation: Common methods include diffuser, aroma lamp, room sprays, or steam.

Direct inhalation of the oils has psychological effects through olfactory links with the limbic system and has a rapid onset of action.

Baths: Essential oil should be mixed with a carrier such as sea salt, Epsom salt, or carrier oil; may be used for full bath, foot bath, bed bath, or sitz bath.

Compresses: Essential oil diluted and applied to clean cloth or flannel cloth can be applied hot or cold; normally left in place for 1–3 hours.

Internally (oral or rectal): Administered only under the supervision of a licensed medical practitioner qualified to administer essential oils.

Although common practice in France and Australia, oral use in the US is uncommon and generally not advised (76-77).

**PHYTOTHERAPY**

Herbal medications are commonly used in all medical settings, making it essential for primary care providers to learn about the products being used and resources they can access for continuing education. Understanding how herbal medicines are sourced, processed, and standardized can help providers guide patients who are trying to choose the most clinically effective and affordable treatments. Multiple herbs are often combined and sold as proprietary blends, which can increase the risk of allergies, adverse reactions, or cross-reactivity with other pharmaceuticals and supplements. Several textbooks, online point-of-care resources, and conferences are available for primary care providers to expand their knowledge of herbal medicines.Modern phytotherapy and phytocosmetology search for herbal medicines and phytocosmetics from natura lor processed raw materials obtained from medicinal plants and their use in disease prevention, therapy, cosmetology and food production. (78)

**AYURVEDA**

Ayurveda, as the “science of life,” is a traditional system of medicine originated in ancient India over 5000 years ago. Rooted in Hinduism’s philosophical and spiritual traditions, Ayurveda is based on achieving balance and harmony within the body, mind, and spirit to promote health and wellness. As one of the world’s oldest medical systems, Ayurveda encompasses a holistic approach to healing that integrates diet, herbal remedies, yoga, meditation, and lifestyle practices and integrates spiritual and rational elements. Ayurveda is based on doshas, or bodily energies, which must be balanced for optimal health. Dietetics is another key aspect of Ayurvedic medicine, emphasizing eating according to one’s “dosha” or constitutional type. According to Ayurvedic teachings, each individual possesses a unique combination of the 3 doshas—vata, pitta, and kapha—which govern various physiological functions and personality traits. Imbalances in the doshas are thought to contribute to disease. Ayurveda aims to restore equilibrium and promote holistic well-being through personalized treatments and lifestyle interventions.

The origins of Ayurveda can be traced back to the Vedic period, a time of great intellectual and cultural flourishing in ancient India. The Vedas, the oldest sacred texts of Hinduism, reference healing rituals, medicinal plants, and spiritual practices to promote physical and mental well-being. Ayurveda emerged as a synthesis of these diverse traditions, drawing upon the insights of ancient sages and practitioners who sought to understand the nature of health, disease, and the human condition. Central to Ayurvedic philosophy is the concept of the “panchamahabhutas,” or the 5 elements—earth, water, fire, air, and ether—which are believed to constitute the basic building blocks of the universe and the human body. According to Ayurvedic teachings, health is maintained when these elements balance and harmony within the body. At the same time, disease arises when there is an imbalance or disturbance in their proportions.

Ayurvedic medicine encompasses many therapeutic modalities, including dietary recommendations, herbal medicine, dietetics, detoxification, massage, yoga, meditation, and spiritual counseling. Herbal remedies, known as “rasayanas” or “ayurvedic herbs,” play a central role in Ayurvedic pharmacology, with thousands of medicinal plants used for their therapeutic properties.Herbs such as turmeric, ginger, neem, and ashwagandha are prized for their anti-inflammatory, antimicrobial, and adaptogenic properties, which are believed to promote vitality, longevity, and resilience.

Ayurvedic practitioners view health as physical, mental, and spiritual harmony. This holistic approach is increasingly recognized in contemporary integrative medicine, which seeks to combine the best of traditional and modern medical practices. In contemporary healthcare, the synthesis of spiritual and rational approaches is embodied in integrative medicine. Integrative medicine combines conventional biomedical treatments with complementary therapies such as acupuncture, meditation, yoga, and herbal medicine. This approach recognizes that health is not merely the absence of disease but a well-being encompassing physical, mental, and spiritual dimensions. Integrative medicine aims to treat the whole person, considering lifestyle, environment, psychological factors, and clinical symptoms.

The resurgence of interest in holistic and integrative approaches in modern healthcare can be attributed to several factors. Patients increasingly seek treatments that address their overall well-being rather than specific symptoms. There is also growing recognition of the limitations of conventional biomedicine, particularly in managing chronic diseases and promoting preventive care. Integrative approaches offer a more comprehensive model of care that aligns with patients’ desires for personalized and holistic treatments.

At the same time, dietary modifications, such as eating seasonally, consuming fresh, whole foods, and avoiding processed refined foods, are recommended to restore balance and promote optimal health. Detoxification, known as “panchakarma,” is a cornerstone of Ayurvedic therapy aimed at removing accumulated toxins and impurities from the body through cleansing practices such as fasting, herbal enemas, oil massages, and steam baths. Panchakarma therapies are believed to rejuvenate the body, mind, and spirit, promoting deep relaxation, purification, and revitalization.

Massage, or “abhyanga,” is another important therapeutic modality in Ayurveda, with a long history of use for promoting physical, mental, and emotional well-being. Ayurvedic massage techniques involve the application of warm herbal oils to the body, followed by gentle kneading, rubbing, and stroking to release tension, improve circulation, and stimulate the flow of vital energy. Massage is often combined with aromatherapy, sound therapy, and energy healing techniques to enhance its therapeutic effects.

Yoga and meditation are integral to Ayurvedic practice, focusing on cultivating awareness, mindfulness, and inner peace. Yoga, derived from the Sanskrit word meaning “union,” encompasses a variety of physical postures (asanas), breathing techniques (pranayama), and meditation practices (dhyana) aimed at harmonizing body, mind, and spirit. Meditation, or “dhyana,” involves cultivating focused attention and mental clarity through mindfulness, visualization, and mantra repetition. Spiritual counseling, or “Satsang,” is another important aspect of Ayurvedic medicine, providing guidance, support, and inspiration on the path to holistic healing and self-realization. Ayurvedic practitioners, known as “vaidyas” or “ayurvedic doctors,” serve as teachers, mentors, and healers, offering personalized consultations, lifestyle recommendations, and spiritual guidance to help individuals achieve balance and harmony in their lives.

Ayurveda is one of the ancient yet living health traditions, that practices holistic principles focused on personalized health. Ayurveda is referred as ‘science of life’ because the Sanskrit meaning of *Ayu* is life and *Veda* is science or knowledge. *Charaka Samhita*, *Sushruta Samhita* (~400 BC–200 AD) *and Ashtanga Hridaya of Vagbhata* are main classics, which give detailed descriptions of over 700 herbs and 6,000 formulations. *Madhav Nidan* (~800 AD), a diagnostic classic, provides over 5,000 signs and symptoms. Life in Ayurveda is conceived as the union of the body, senses, mind and spirit. The concept of *Prakriti* or individual nature has a central role in Ayurveda therapeutics.

Ayurveda, which is a person-centered holistic medicine (PCM), deals with healthy lifestyle, health promotion and sustenance, disease prevention, early diagnosis and personalized treatment. There are substantial similarities between the traditional systems like Ayurveda and the innovative approach of predictive, preventive and personalized medicine (PPPM). Ayurveda, that has personalized approach involving constitutional assessment, which can guide primary prevention, diagnosis and therapeutics, offers detailed guidance about food, nutrition and diet as per the individual constitution or *Prakriti* as well as seasons. The scientific value of basic principles of Ayurveda like *Prakriti* is being studied in context to biology and genomics.

Basic principles of Ayurveda as an ancient science of life are valid even today. The mode of manifestation of disease has changed as well as the geo-climatic environment, plants, animals and microbes, human behavior, lifestyle and genetics. Clearly, classical Ayurveda of yesteryears cannot be blindly practiced without contemporary modifications. The epistemology of Ayurveda is based on the relation between microcosm and macrocosm involving five basic elements (*mahabhoota*), three dynamic principles similar to humors (*dosha*), seven types of tissues (*dhatus*) and many other unique concepts. Ayurveda is experiential, intuitive and holistic, whereas that of the modern medicine is based more on experimental, analytical and reductive reasoning. The relationship between Ayurveda and modern science is similar to the relationship between the ‘whole’ and the ‘parts’, where the sum of the parts need not be equal to the whole. Modern medicine is based more on rationalism, reductionism with deeper understanding of molecules, cells, organs or diseases as parts. In the process, the sight of the whole person seems to be neglected. Integrative, whole system approaches like PPPM and PCM as well as traditional and holistic systems like Ayurveda need to be scientifically evaluated and integrated.

Ayurveda is uniquely patient-oriented where the Ayurvedic physician diagnoses, treats and dispenses medicine to every individual patient. This important principle can form the basis for a form of personalized medicine which will give maximum therapeutic efficacy and high safety to a particular person with a particular disorder, under specified conditions depending on individual constitution, and properties of materials. *Prakriti* specific prescription may also include supportive therapies, diet and life-style advice to regain physiological balance, resulting in the removal of the disorder.

A decision-support system known as AyuSoft (developed by Center for Development of Advance Computing and University of Pune, Ganeshkhind, Pune India) based on Ayurveda knowledge has been shown to be useful in determination of individual *Prakriti* and personalized treatments. According to Ayurveda constructs, doshas are the dynamic principles, which govern a person’s physical, physiological and psychological functions including metabolism. Ayurveda describes three doshas namely vata, pitta, and kapha. The proportional domination of doshas in an individual is expressed as *Prakriti*, which broadly mean a body type or individual nature. An Ayurvedic physician determines the *Prakriti* of a patient so as to personalize treatment. The Ayurvedic description suggests that the innate dispositions are represented by individual *Prakriti*, which represent phenotypes.

Going beyond genomics is necessary to understand how environment and behaviors can be responsible for inheritable changes when the genome remains unchanged. Ayurvedic concept of *shatkriyakaal* elaborates a six-stage progressive transition from balanced to unbalanced stage (from a healthy state to diseased state) leading to disease manifestation in a person with slow but progressive pathophysiological changes. These six stages may help early recognition and diagnosis before onset of measurable clinical symptoms of diseases following pathophysiological, genetic, and epigenetic and metabolomic differences. This may lead towards the identification of new biomarkers and early predictions, to be used for prevention and personalized treatments.

Shatkriyakala the six stages of disease progression are as follows:

a)Sanchaya (Stage of Accumulation) : Progressive collection of Doshas in their own places occurs in this stage; this stage initiates pathogenesis of disease.

Doshas accumulate in their respective seats and exhibits following symptoms:

Vata Sanchaya Lakshana: Stiffness and fullness in abdomen.

Pitta Sanchaya Lakshana: Slight rise in body temperature and burning senses.

Kapha Sanchaya Lakshana: Feeling of heaviness

b) Prakopa (Stage of Aggregation) Doshas ready to move from their own place to another place.

c) Prasara (Stage of Dissemination) Doshas leave their places and moves to other parts of body and spread through different Strotas

d) Sthanasamshraya (Stage of Localization) The abnormality in Srotas causes obstruction of the Doshas.b The vitiated Doshas can vitiate organ and produces a disease of that particular organs in which morbid Dosha gets accumulated. This stage exhibits premonitory signs and symptoms (Poorva rupa) of disease

e) Vyaktavastha (Stage of Manifestation) The signs and symptoms can be observed in this stage, thus Vyaktavastha is considered as stage of manifestation. The main symptoms can be seen in this stage so treatment can be planned accordingly.

f) Bhedavastha (Stage of Complication) Bhedha is final stage of disease progression in which complications of disease may observe and origin of other diseases may take places.

Ayurveda concept does not consider the disease in isolation but the diseased ‘person’. Due to the emphasis on restoring wholeness, use of natural remedies focus on emotional health, and prevention strategies being unique features of Ayurvedic interventions. The new philosophy of health care is moving from illness to wellness, from treatment to prevention and early diagnostics and from generalized approach to personalized medicine. (79)

[**TRADİTİONAL CHİNESE MEDİCİNE**](https://www.sciencedirect.com/topics/medicine-and-dentistry/traditional-chinese-medicine)**(TCM),**

[Traditional Chinese medicine](https://www.sciencedirect.com/topics/medicine-and-dentistry/traditional-chinese-medicine) (TCM), which is a a traditional holistic medical system practiced for over 2500 years in China and other East Asian parts, has its roots in ancient Chinese philosophical and cultural traditions and religion. It is based on the ideas of balance and holism in the body. It is a knowledge system that the Chinese people have condensed and summarized throughout thousands of years of use in healthcare. The term "Traditional Chinese Medicine" (TCM) encompasses a broad spectrum of conceptual frameworks, modalities, and treatment regimens, many of which have evolved and modernized over the course of the last 2000+ years in order to meet contemporary standards and ways of thinking. The ancient roots of acupuncture, Chinese herbal medicine, moxibustion, massage, bleeding, and cupping may be traced in the history of classical Chinese medicine.

The prime source of knowledge about early Chinese medicine is the 2,000-yearold Huangdi Neijing (Yellow Emperor’s Classic of Internal Medicine). The Huangdi Neijing, an ancient Chinese medical text, takes the format of question and answer discussions between the semi-mythical Yellow Emperor, Huang-di, and his advisors. It includes diagnostic procedures such as feeling the pulse, observing the tongue, and examining human excrement, as well as a range of treatments, including herbal and mineral mixtures, massage, special diets, bathing, meditation, and forms of physical exercise and ritualized movements. The concept of yin-yang has permeated Chinese philosophy, culture, anD medicine for millennia. It represents the inherent duality—opposite in the universe. Yin is described as dark, watery, cool, passive,and feminine, while yang is bright, dry, hot, active, and masculine—and each cannot exist without the other.

The term “zang-fu” in Chinese refers not only to the anatomical entities of the internal organs, but also to a generalization of the human body’s function as a system of assigning body parts as either yin or yang. TCM divides the internal organs into two groups, typically coupled in “yin yang” pairs per Phase: “Zang”, or solid organs, which are considered “yin” organs (heart and pericardium, liver, spleen, lung, and kidney), and “fu” or hollow organs, which are considered “yang” organs (small intestine and triple burner, gall bladder, stomach, large intestine, and bladder) .

**History of TCM**

Chinese medicine began during the Shang Dynasty Period (1600–1046 BC), a time of shamanism. At this period, Shang Di was a religious deity who was thought to be accompanied by deceased ancestors and reside in heaven in an imperial court. According to Shang Di, sickness results from two things: either a demon or other evil entered the body and caused illness, or offending an ancestor and receiving a curse as a result. Particularly, more than 20 disease types were recorded in the oracle inscriptions of the Yin Dynasty . According to *Rites of Zhou*, doctors in Zhou Dynasty were divided into four categories: dietician, physician, surgeon, and veterinarian.

In the Spring and Autumn Period (c. 771 BC‒476 BC), medicine and witchcraft were separated, and the theory of yin and yang and five elements, which denied the nature of destiny and supernatural being, began to form.  *The Yellow Emperor's Canon of Medicine* (*Huang Di Nei Jing*) is an essential symbol of Chinese medicine and a link between the past and the future. To date, it remains a guide for theoretical research and clinical practice of TCM.

During the Qin and Han dynasties, *The Classic of Difficult Issues* (*Nan Jing*) further elucidated the essence of the medical classics, and was among the three major medical classics together with *Shen Nong's Classic of the*[Materia Medica](https://www.sciencedirect.com/topics/medicine-and-dentistry/materia-medica) (*Shen Nong Ben Cao Jing*) and Zhang Zhongjing's *Treatise on Cold Damage and Miscellaneous Diseases* (*Shang Han Za Bing Lun*) to advance medicine.  Wang Shuhe of the Western Jin Dynasty (266–316), allowed Zhang Zhongjing's theory of pattern differentiation and formulas to thrive in ancient times and his ten volumes of *The Pulse Classic* (*Mai Jing*) were the first medical books about pulse in China. The theory of [acupuncture](https://www.sciencedirect.com/topics/medicine-and-dentistry/auriculotherapy) and [moxibustion](https://www.sciencedirect.com/topics/medicine-and-dentistry/moxibustion) was recorded in *The Yellow Emperor's Canon of Medicine* and *The Classic of Difficult Issues* during the Han Dynasty (202 BC‒220 CE) .

In the Wei and Jin dynasties, Huang Fumi completed an epoch-making summary work and wrote twelve volumes of *The Systematic Classic of Acupuncture and Moxibustion* (*Zhen Jiu Jia Yi Jing*), while Ge Hong's *Emergency Formulas to Keep Up One's Sleeve* (*Zhou Hou Bei Ji Fang*) preserved many valuable documents and effective prescriptions. This book had recorded the Qiang insect, which was later discovered by Japanese doctors in the 19th century, and the “rabies”, later confirmed by the French scientist Pasteur. The content of [artemisia](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/artemisia) directly inspired the team of Youyou Tu, a modern scientist, to discover and name [artemisinin](https://www.sciencedirect.com/topics/medicine-and-dentistry/artemisinin), contributing significantly to the research of [antimalarial drugs](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/antimalarial-agent) globally.

Medical education in China has always been inherited between family members or masters and apprentices. In the Liu-Song period (420–479), medical officials such as the minister of medicine and assistant of imperial physician were teaching medicine; the Sui Dynasty government (581–618) established an imperial medical academy. The medical administration of the Tang Dynasty (618–907) imitated the Sui system, with the imperial medical academy and the medicine bureau, responsible for the medical administration of the government and the court, respectively, as well as the national medical education and the medical and [health care](https://www.sciencedirect.com/topics/medicine-and-dentistry/health-care) of the royal family.Lin Daoren's *Secrets of Treating*[*Wounds*](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/wound)*and Rejoining Fractures Handed Down by an Immortal* (*Xian Shou Li Shang Xu Duan Mi Fang*) were the earliest existing monograph on [traumatology](https://www.sciencedirect.com/topics/medicine-and-dentistry/traumatology) in China, involving fracture repair, traction, reposition, and others.

Zan Yin's *Valuable Experience in*[*Obstetrics*](https://www.sciencedirect.com/topics/medicine-and-dentistry/obstetrics) (*Jing Xiao Chan Bao*) is the earliest existing monograph on obstetrics in China elaborating the diagnosis and treatment of pregnancy, [dystocia](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/dystocia), and postpartum diseases. The [pediatric](https://www.sciencedirect.com/topics/medicine-and-dentistry/pediatrics) monograph *The Cranial Fontanelle Classic* (*Lu Xin Jing*) recorded for the first time the method of children's pulse-taking, and contains numerous original ideas on etiology; in [otorhinolaryngology](https://www.sciencedirect.com/topics/medicine-and-dentistry/otorhinolaryngology), records of inlaying teeth and filling teeth existed in Sui and Tang dynasties, while in [ophthalmology](https://www.sciencedirect.com/topics/medicine-and-dentistry/ophthalmology), a technique of using needles to remove cataract was discovered.

The *Essentials from the Silver Sea* (*Yin Hai Jing Wei*) written by Sun Simiao of Tang Dynasty was the earliest [ophthalmic](https://www.sciencedirect.com/topics/medicine-and-dentistry/agents-acting-on-the-eye) classic in China but has been lost. His representative works of *Important Formulas Worth a Thousand Gold Pieces* (*Qian Jin Yao Fang*) and *Supplement to ‘Important Formulas Worth a Thousand Gold Pieces’* (*Qian Jin Yi Fang*) encompassed a large number of ancient prescriptions and clinical experience, while emphasizing maternal and child health care, advocating for diet therapy and comprehensive treatment, focusing on drug collection and processing, opposing the trend of taking unnecessary pills, and highlighting the compatibility of prescriptions and drugs.

*Arcane Essentials from the Imperial Library* (*Wai Tai Mi Yao*) is another comprehensive prescription collection. From the second to the fourth year of Xianqing's reign of the Tang dynasty, the government organized the compilation of the first pharmacopeia of China, *Newly Revised Materia Medica* (*Xin Xiu Ben Cao*), another essential work after the *Shen Nong's Classic of the Materia Medica* and Tao Hongjing's *Collective Commentaries on the Classic of Materia Medica* (*Ben Cao Jing Ji Zhu*). It laid a solid foundation for the later compilation of the official revised *materia medica* in Song Dynasty (960–1279), the *Materia Medica Arranged According to Pattern* (*Zheng Lei Ben Cao*) by Tang Shenwei and *The Grand Compendium of Materia Medica* (*Ben Cao Gang Mu*) by Li Shizhen in Ming Dynasty (1368–1644).

On the 13th year of the Tianbao reign of Tang, master Jianzhen traveled to Japan to give lectures on Buddhism and treat the diseases affecting the Japanese people . Due to his advanced medical skills, he was high prominent in the Japanese medicine field and was considered the ancestor of Chinese medicine and the Shennong of Japan. The works of master Jianzhen report the spread of TCM. In the Song Dynasty, there were medical exchanges between China and Southeast Asian countries, such as the Jiaozhi country, Zhancheng country, and Ananan country (all are now regions of Vietnam). The Yuan Dynasty (1271–1368) had close relations with Korea, Arabia, Southeast Asia, and other countries.The Song Dynasty was an essential period for the development of medicine and appointed personnel to compile large-scale prescriptions, such as *Formulas from Benevolent Sages Compiled during the Taiping Era* (*Taiping Shenghui Fang*), *Beneficial Formulas from the Taiping Imperial Pharmacy* (*Taiping Huimin Heji Jufang*), and *Comprehensive Recording of Divine Assistance from the Zhenghe Era* (*Zhenghe Shengji Zonglu*)*,* cast bronze models, compile *Illustrated Classic of*[Acupoints](https://www.sciencedirect.com/topics/medicine-and-dentistry/acupuncture-point)*on the Bronze Figure* (*Tong Ren Shu Xue Zhen Jiu Tu Jing*) for teaching purposes, and set up charities, such as Huimin and Heji Bureau.

The propagation of printing technology led to a significant increase of the number of medical books. Regarding [internal medicine](https://www.sciencedirect.com/topics/medicine-and-dentistry/internal-medicine), *Treatise on Diseases, Patterns, and Formulas Related to the Unification of the Three Etiologies* (*San Yin Ji Yi Bing Zheng Fang Lun*) was published. Regarding other fields, the following works appeared: *Essence of External Medicine* (*Wai Ke Jing Yao*)*, The Complete Compendium of Fine Formulas for Women* (*Fu Ren Da Quan Liang Fang*)*, Chen's Formulas for Childhood Pox* (*Chen Shi Xiao Er Dou Zhen Fang*)*, Qian's Key to Diagnosis and Treatment of Children's Diseases* (*Qian Shi Xiao Er Yao Zheng Zhi Jue*)*, Classic of Nourishing Life with Acupuncture and Moxibustion* (*Zhen Jiu Zi Sheng Jing*), and others.

During the Jin and Yuan dynasties, the country was heavily affected by disease and wars. To address this issue, a group of famous medical experts and hundreds of schools of medical thought emerged. The representative figures are the four masters of Jin and Yuan dynasties in the [history of medicine](https://www.sciencedirect.com/topics/medicine-and-dentistry/history-of-medicine): Liu Wansu of *Hanliang* school, Zhang Congzheng of *Gongxia* school, Li Dongyuan of *Butu* school, and Zhu Zhenheng of *Ziyin* school.

In the Ming and Qing dynasties, various schools existed in the medical field; however, most of them inherited the knowledge transmitted by the four masters of Jin and Yuan dynasties.  The representative works include Xue Ji's *The Core of External Medicine* (*Wai Ke Shu Yao*) and *Summary of Internal Medicine* (*Nei Ke Zhai Yao*)*,* Wang Kentang's *Standards for Diagnosis and Treatment* (*Zheng Zhi Zhun Sheng*)*,* Zhang Jiebin's *The Complete Works of [Zhang] Jing-yue,* Li Shizhen's *The Grand Compendium of Materia Medica* (*Ben Cao Gang Mu*), *[Li] Bin-hu's Teachings on Pulse Diagnosis* (*Bin Hu Mai Xue*), Chen Shigong's *Orthodox Lineage of External Medicine* (*Wai Ke Zheng Zong*), Li Zhongzi's *Essential Knowledge of the ‘Inner Classic’* (*Nei Jing Zhi Yao*), Wu Youke's *Treatise on Warm-Heat Pestilence* (*Wen Yi Lun*), among which *The Grand Compendium of Materia Medica* and *Treatise on Warm-Heat Pestilence* were the most prominent.

In the Ming Dynasty, various [medical records](https://www.sciencedirect.com/topics/medicine-and-dentistry/medical-record), medical notes, and medical introductory works were kept, including *Introduction to Medicine* (*Yi Xue Ru Men*) and Huang's *Medical Experience* (*Zhe Gong Man Lu*)*.* Furthermore, exchanges of Chinese and foreign medicines were conducted in many countries and regions in Asia, Europe, and Africa. The export of Chinese culture and the introduction of Western culture to China have benefited the Chinese people in terms of medical and cultural exchanges and communications. During the Qing Dynasty (1636–1912), the TCM academic system had been relatively completed and Tianshi established the theory of pathogenesis of febrile diseases and differentiation of protecting the qi and nourishing blood; Xue Shengbai elaborated the etiology, pathogenesis, and treatment of heat illness; Wu Jutong set up the dialectical program for the treatment of [Triple Energizer](https://www.sciencedirect.com/topics/medicine-and-dentistry/triple-energizer); while Wang Mengying integrated the theory of febrile diseases of the previous dynasties and expedited the treatments of infectious diseases and epidemics.

The medical exchanges between China and foreign countries, helped Chinese medical experts to receive knowledge on [vaccination](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/vaccination-policy), [anatomy](https://www.sciencedirect.com/topics/medicine-and-dentistry/anatomy), medicine, and surgery. TCM practice uses a variety of combinations of herbs, animal products, and minerals, together referred to as TCM formulas. Currently, 61,000 unique chemical entries are held in the well-annotated library of natural compounds isolated from TCM database in Taiwan . A group of US and Chinese scientists created a prototype TCM specimen library in the early 2000s with funding from NCI, Harvard Medical School, Beijing University of Chinese Medicine, and Hong Kong Baptist University. The library contained over 200 verified species of medicinal plants and fungi, which together represent the therapeutic content of most commonly, prescribed . The resultant extracts of a portion of this collection has been added to the Natural Products Repository, which houses over 230,000 distinct extracts from microorganisms, plants, and marine life. The Natural Products Repository is one of the biggest natural product collections in the world. Southeast Asia, Africa, Central and South America, and other continents provided the bulk of the over 80,000 plant samples housed in this library.

The origins of TCM can be traced back to the early Zhou Dynasty in China, as the earliest records of herbal medicine can be found in the Classic of Changes (Yi Jing) and Classic of Poetry (Shi Jing) . Applying the concept of Yin and Yang, such as cold-hot, female-male, and inside-outside, to the human body, Yin and Yang are associated with various bodily organs or components, or even just with how hot or cold a person feels. Prior to the 20th century, TCM—which heavily relied on herbal medicine—was the only medical service available to the majority of Chinese people. Chinese herbal medicine’s (CHM) story tradition, has been transmitted orally or in the form of classics in Chinese societies until today.

According to mythology, the elements fire, air, water, and earth make up the cosmos and the human body, with fire representing the liver, air representing the heart, water representing the brain, and earth representing the spleen. The characteristics of each element, such as warm and dry for fire are described by the four primal qualities of warm, cold, dry, and moist. The primary sources of TCM are natural medicine and its processed goods, include chemical and biological products as well as herbal, animal, and mineral medicines.

According to traditional Chinese beliefs, health relies on the concept of qi (pronounced “chee”) , the vital force,energy stream or life flow moving through the body along routes or channels called meridians and animates all living beings and improves circulation, and harmonize body, mind, and spirit.. The "four qi" (four natures of medications), "five flavours" (five tastes of drugs), meridian entry, and ascending and descending, floating and sinking force of medicinal action are among the primary features of the unique property hypothesis ,based on the notion of zang-fu organs and meridians and developed over long-term clinical practise, led to the treatment of specific ailments with medications guided by the fundamental TCM theory. Problems such as pain and illness arise when someone’s qi is disturbed. Acupuncture aims to correct the flow and restore the qi balance by inserting very thin needles into the skin and underlying tissues at specific sites called acupuncture points

The origins of TCM can be traced back to the ancient Chinese philosophy of Daoism (Taoism), which emphasizes the harmonious interplay of opposites and the interconnectedness of all things. According to Daoist teachings, health is maintained when the body, mind, and spirit are in balance and harmony, while illness arises from imbalances or blockages in the flow of qi. TCM seeks to restore equilibrium and promote holistic well-being through personalized treatments and lifestyle interventions.

One of the foundational texts of TCM is the Huangdi Neijing, or “Yellow Emperor’s Inner Canon,” which dates back to the 2nd century BCE. Compiled during the Han dynasty, the Neijing is a comprehensive treatise on medicine, physiology, pathology, diagnosis, and treatment, containing insights into the nature of qi, the principles of yin and yang, and the functions of the organs and meridians. The Neijing provides a theoretical framework for understanding health and disease that continues to inform TCM practice.

Central to TCM diagnosis is the concept of pattern identification, or “bianzheng,” which involves analyzing the signs and symptoms of a patient to identify the underlying pattern of disharmony or imbalance. TCM recognizes various patterns, or “zheng,” including excess and deficiency patterns, hot and cold patterns, and interior and exterior patterns, which reflect the dynamic interplay of yin and yang forces within the body. Based on the pattern identified, TCM practitioners prescribe individualized treatments tailored to each patient’s unique needs.

One of the key diagnostic tools in TCM is pulse diagnosis, known as “pulse-taking,” which involves assessing the quality, rhythm, and strength of the pulse at various positions on the radial artery. According to TCM theory, the pulse provides valuable information about the state of the organs, the flow of qi and blood, and the overall balance of yin and yang within the body. By carefully palpating the pulse, TCM practitioners can detect subtle imbalances and disturbances that may not be apparent through other diagnostic methods.

There are four types of TCM compounds used in modern medicine:

the traditional prescription, which is mostly in the form of ready-made medication;

the modified traditional prescription, which is mostly in the form of decoction;

the self-made prescription and specific prescription, which is formulated by hospitals or related departments and clinicians based on their clinical experience and includes decoction, capsule, and other modern dosage forms; and

the TCM developed and produced in modern methods.

TCM encompasses many therapeutic modalities to promote health, prevent illness, and treat disease. In clinical practise, TCM emphasises "patterns" and employs several Western medicine techniques to comprehend the sick state of the human body. There are some Western medical "diseases" that fit the TCM "pattern." The "pattern differentiation" of the "disease" recognised by Western medicine has been thoroughly studied by traditional Chinese physicians who combine Eastern and Western treatment. TCM is beneficial in treating psychogenic diseases, diseases with unclear aetiology or complex pathology, and functional ailments.

In particular, TCM recognises 12 kinds of prevalent diseases:

(1) Viral infectious illnesses, include persistent viral hepatitis and influenza.

(2) Functional illnesses, include amnesia, weariness, palpitations, persistent dyspepsia, irritable bowel syndrome, cardiac and gastric neuroses, and fevers that are not yet known.

(3) Age-related and chronic illnesses, such as coronary heart disease, hyperlipidemia, diabetes, anaemia, hypopsia, deafness, emphysema, cor pulmonale, chronic gastritis, chronic colitis, chronic nephritis, chronic urinary infection, and sequelae of apoplexy.

(4) Illnesses including menopause, cancer, AIDS, relapsed drug addiction, and hypotension that have unclear or complicated origins.

(5) Mental and neurological conditions such facial paralysis, sadness, mania, headaches, sleeplessness, forgetfulness, and psychoneurosis.

(6) Disorders of the connective tissue, include systemic lupus erythematosus, rheumatism, and rheumatoid arthritis.

(7) Orthopaedic conditions like femoral head osteonecrosis, fracture, osteopathy, bone tumour, and joint deformity.

(8) Skin conditions such psoriasis, leukoplakia, alopecia, neurodermatitis, and eczema.

(9) Obstetrical and gynaecological conditions, including dysmenorrhea, menstrual disorders, climacteric syndrome, premenstrual syndrome, hyperplasia of the breast lobules, pregnancy and postpartum diseases (such as serious pregnancy reaction, postpartum agalasisa, and regurgitation of milk), and female infertility.

(10) Disorders related to andrology, such as male infertility, prostatitis, spermatorrhea, oligospermia, and necrospermia.

(11) Diseases of the paediatric population, such as recurring upper respiratory tract infections in infants, newborn diarrhoea, infantile anorexia, and malnutrition, as well as a variety of viral infectious diseases (such as upper respiratory infections, mumps, and viral pneumonia).

(12) Initial recovery from a serious illness and sub-health, including managing symptoms such as low-grade fever, dyspepsia, night sweats, dizziness, sleeplessness, lack of appetite, and general weariness following a serious illness.

Narrative is significant because it preserves an ethnic group’s identity by going beyond shared experiences to become a belief system. From Traditional Chinese medicine (thousands of years ago) to Modern medicine (recent decades)

1. The integration of life knowledge/ experience with traditional Chinese medicine. From early research on a single gene or protein to the application of proteomics, informatics, and genomics today

2. The relationship between a person’s emotions and their surroundings. Gradual understanding of the role of psychological variables in physiology and pathophysiology.

3. Differentiating between syndromes, adherence to the triple pathogen theory, and body theory. Establishment of individual treatment

4. Chinese compound (multitarget herbal treatment). Reduce medical treatment side effects dramatically by switching from single-target to multitarget medications.

TCM offers an example of the fusion between spiritual and rational approaches. TCM is based on the concepts of yin and yang and the 5 elements, which represent different aspects of the natural world and their relationships. Health is seen as a state of balance between these forces, and illness results from an imbalance. Treatments in TCM, such as acupuncture, herbal medicine, and qigong, aim to restore this balance. These practices are grounded in detailed empirical observations and validated by centuries of clinical use. Yet, they are deeply rooted in a spiritual understanding of harmony and balance within the body and the universe.

*Daoyin* has been created by ancient Chinese and inherited through generations as a set of medical and health exercises integrating breathing and body movement. By imitating the animal's movement in line with the idea of “blowing and breathing, exhaling the old and inhaling the new,” it may improve the circulation of qi and blood, thus prolonging life. The most typical *Daoyin* include *Wuqinxi* (five-animal exercises), *Baduanjin* (eight-sectioned exercise), and *Yijinjing* (muscle-bone strengthening exercise).

Fig.6.  Daoyintu: Chart for leading and guiding people in exercise (Wellcome; Creative Commons Attribution 4.0)



The core concept of TCM is the unity or the correspondence between human and nature or universe and their harmonious coexistence. The core modes of thinking are image, intuitive, and fuzzy thinking, while the core behavior mode is learning from nature and keeping the body balance. The holistic concept of “unity of human and nature” in TCM embodies ancient Chinese philosophy, in which both have an integrated relationship of mutual inclusion, connection, and coordination. Humans can remain healthy only by adapting to the changes of nature and positively interacting with them. According to this holistic concept, understanding an individual requires awareness of the overall background, including the external environment and various relationships. This concept emphasizes the integrity of human and nature and considers the human body a small universe. Therefore, the five *zang*-organs, six *fu*-organs, meridians, qi (vital energy) and blood, and other organizational systems inside the human body should be systematically integrated with external factors, such as the natural and social environment, and time factors, such as the four seasons and day and night.[https://www.sciencedirect.com/science/article/pii/S2095754821000909](https://www.sciencedirect.com/science/article/pii/S2095754821000909#bib1)

TCM considers that the pattern (image information) of internal illnesses of the human body provides the necessary information basis for thinking and diagnosis. Image thinking originated from nature and daily life. The existence of human beings and everything in nature is inevitably shown by their “appearance,” referred to as “image” in Chinese. For example, when a person is happy, a smile appears on his/her face. The most typical expression of a smile includes narrowed eyes, open mouth, and a happy voice. Although a smile may be divided into laughter, smile, sneer, wry smile, mischievous smile, giggle, and others, each of them having different [facial features](https://www.sciencedirect.com/topics/medicine-and-dentistry/facies), the two corners of the mouth remain upward; otherwise, it will not be considered a smile, which determines the “standard” of a certain “image.” These facial expressions are “images” representing people's inner activities. Smile in different backgrounds has varied meanings; thus, by analyzing different “smile images,” the inner world and mood of a person can be understood..

TCM image thinking refers to observing the signs of the human body and then using reasoning methods, such as association, metaphor, comparison, symbolism, analogy, yin and yang, and five elements, to speculate and analyze the physiological and pathological conditions inside the body, thus reaching to cognitive conclusions with attributes and relationship characteristics.Image thinking refers to analyzing the “image” and summarizing it into various “patterns”; the specific “pattern” is determined through pattern differentiation, followed by “treatment” of the “pattern.” Pattern differentiation refers to understanding, grasping, and responding to the “image.” This process is different from the thinking mode of logical analysis.

TCM considers “image” the core and evaluates the signs of the human body through external observation and internal speculation to analyze the physiological and pathological conditions of the body and obtain the clinical “image” information through the four diagnostic methods.[https://www.sciencedirect.com/science/article/pii/S2095754821000909](https://www.sciencedirect.com/science/article/pii/S2095754821000909#bib1) TCM adheres to “learn from nature” and advocates for the mobilization of natural resources inside and outside of the human body. TCM utilizes the [disease resistance](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/disease-resistance) ability in nature and the human body, adopts the natural and harmonious way of treatment to stimulate the body's vitality, eliminates pathogenic factors and products, repairs organic damage, recovers the organs, removes mental and psychological disorders, and ultimately restores health.[https://www.sciencedirect.com/science/article/pii/S2095754821000909](https://www.sciencedirect.com/science/article/pii/S2095754821000909#bib1)

TCM is a major practice for disease treatment and is evidence by multiple resources. There are 12 807 types of Chinese medicinal materials, including 11 146 types of plant medicine, 1581 types of animal medicine, 80 types of mineral medicine, 5000 types of Chinese patent medicine, and above one million prescriptions.  In Western medicine, symptom-perception gradually becomes disease-perception, which means a deeper understanding of its nature. In TCM, the manifestation and differentiation of syndromes rather than diseases are essential to selecting the appropriate therapeutic intervention. Syndromes, also known as “zheng”, are symptoms of disturbances of visceral function and “yin yang” balance evoked by pathogenic factors. These originate signs that can be detected, for example, in tongue and pulse diagnosis. Many Western medicine diseases may be similar to some “syndromes” in TCM, while some “syndromes” may include certain Western medicine diseases .

For example, the kidney’s essence, known as “jing”, is an essential concept related to the process of aging. According to TCM, each person is born with a finite amount of “jing” stored in the kidneys and gradually uses it through life. Some authors consider “kidney deficiency syndrome” equivalent to aging in Western medicine. Similarly, “heart qi deficiency” is associated with cardiac insufficiency .Within the interstitial connective tissue, TCM meridians or conduits and collaterals constitute a network called “jing luo”. These conduits, believed to serve as channels for the flow of “qi” and “xue”, are connections between acupoints with effects on specific orbs’ clinical signs. There are 12 primary meridians, 6 “yin” and six “yang”, classified as the 3 “yang” meridians of the hand, the 3 “yang” meridians of the foot, 3 “yin” meridians of the hand, and 3 “yin” meridians of the foot. The “yin” meridians pertain to the “zang” organs and the “yang” meridians to the “fu” organs. In this way, “qi” and “xue” flow through them and reach every part of the body in a cyclical circulation .

Although the written history of Chinese materia medica dates back from the Eastern Han dynasty (AD 25–220), with the “Shen Nong Ben Cao Jing” (Divine Husbandman’s Classic of Materia Medica), also known as The Canon of Materia Medica, or Shennong’s Herbal Classic, Chinese knowledge of botanic medicine dates back to the discovery of “Ma Huang” (*herba ephedrae*), around 3000 BC. This herb was initially used as a stimulant but was also used for respiratory disorders and other diseases. The active ingredient in *herba ephedrae* is ephedrine, an effective bronchodilator, making “Ma Huang” central in asthma treatment .

Herbal medicine is a cornerstone of TCM therapy, with thousands of medicinal plants and mineral substances used for their therapeutic properties. TCM herbal formulas are carefully crafted combinations of herbs selected for their synergistic effects and tailored to the specific pattern of disharmony identified in each patient. Herbs are typically prescribed as decoctions, powders, pills, or tinctures and may be taken orally, applied topically, or used externally in poultices and compresses.

Chinese herbal medicine and dietetics, known as Chinese materia medica, follow the same diagnostic principles as acupuncture, “Tuina” and “Qigong”. This branch of TCM is focused on the beneficial effects of herbs and foods on the body. Those are classified according to the thermal nature, flavor or “sapor”, organ network, and functional effect direction. The thermal nature has a cooling or warming effect on the body by acting on microcirculation. The “sapor” relates to the Five Phases and regulates a particular organ network .

Regarding the thermal nature, “hot” herbs and foods such as pepper, chili, and garlic have heating, warming effects on the body, increasing “yang”, speeding up the “qi”, activating, dispersing, and moving upward and outward, warming the bowels and viscera (“zang-fu”), eliminating external and internal cold, and mobilizing defense energy. Oppositely, “Cold” foods, such as tomatoes and bananas, cool the body, cool internal heat, and have a calming effect on the spirit (“shen”). Warm and cool herbs and foods have a milder effect on the body, strengthening “yang” and “qi” and supplementing body fluids (“jin ye”) and “xue”, respectively .

According to the Heidelberg model of TCM, the flavors or “sapors” are considered therapeutic vectors within the system . Flavors can be classified according to their “yin” or “yang” quality, and each one belongs to one of the Five Phases:

* Sweet belongs to the Phase Earth (spleen and stomach). It has a warming, strengthening, harmonizing, relaxing, and moistening effect. Sweet has the most potent supplementing effect on the body;
* Acrid or pungent belongs to the Phase Metal (lung and large intestine). It moves the “qi”, invigorates energy circulation, loosens stagnation, disperses, opens pores, frees the surface of exogenous disease factors, and produces perspiration;
* Salty belongs to the Phase Water (kidney and bladder). It cools, moistens, produces a downward bearing, softens, and loosens;
* Sour belongs to the Phase Wood (liver and gallbladder). It has an astringent effect, and gathers and preserves fluids;
* Bitter belongs to the Phase Fire (heart and small intestine). It has a drying, hardening, and downward-bearing effect.

Along with their general effects, each “sapor” directly affects a specific “orb” within each Phase and has an indirect effect within the Phases network. As mentioned in the “Huangdi Neijing”, “Sourness enters the liver, bitterness enters the heart, sweetness enters the spleen, acridity enters the lungs, and saltiness enters the kidneys.” Thus, “Sourness enters the sinews, bitterness enters the blood, acridity enters the qi, sweetness enters the flesh, and saltiness enters the bones.”Herbs and foods can also be classified according to the effective therapeutic direction. Therefore, they can act on the surface or “extima”, or affect the depth, the “intima”, or the “yin” itself.

Moxibustion, also known as moxa-moxibustion, is a form of therapy that involves burning dried mugwort (Artemisia vulgaris) and ironing moxibustion sticks or moxibustion grass on or near acupuncture points to warm and invigorate the flow of qi and blood.  The heat generated by moxibustion is believed to penetrate deeply into the body, promoting circulation, relieving pain, and expelling cold and dampness. Acu-moxa therapy (“zhen jiu”) is a general term covering several techniques designed to stimulate acupoints located on the body along the circulation tracts or conduits. These practices either alleviate local symptoms, affect orbs’ functions, or treat the underlying imbalance causing the symptoms. Although TCM involves many other techniques, acupuncture and moxibustion are the most popular. Acupuncture (“zhen”) is based on the proper insertion and manipulation of needles of various gauges and lengths into the skin at specific acupoints.

Pushing, holding, lifting, kneading, and stroking the body’s meridians and acupoints is known as Tuina massage. Cupping therapy, another ancient healing practice used in TCM, involving the application of glass or bamboo cups to the skin to create a vacuum effect that draws stagnant blood and qi to the surface, alleviates muscle tension, improves circulation, and promotes detoxification, especially combined with acupuncture and moxibustion for enhanced therapeutic effects. In traditional Chinese medicine, cupping, the best deep tissue massage, plays the role of leak or purging . It provides the body tapotement, or massage strokes. Tapotement is a fast, forceful, rhythmic stroke used in therapy to activate muscles, akin to hacking, tapping, slapping, or pummeling..

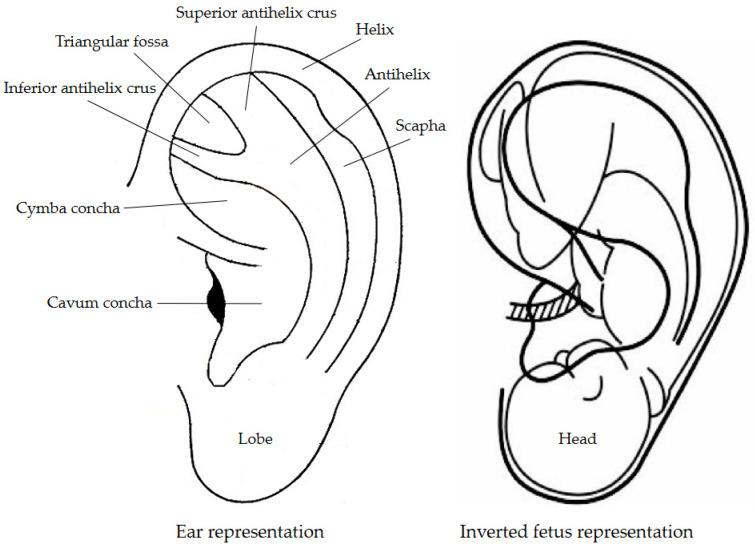
Dietary therapy, exercise, and lifestyle counseling are integral components of TCM, emphasizing preventing illness and promoting longevity through balanced nutrition, regular physical activity, and mindfulness practices. TCM dietary principles are based on the concepts of yin and yang, the 5 elements (wood, fire, earth, metal, water), and the energetics of foods, with an emphasis on eating seasonally, locally, and in harmony with one’s constitution and environment. Qigong and tai chi, ancient Chinese exercise systems, are also used in TCM.

Acupuncture can be traced back to the Stone Age in ancient China, when people used pointed stone implements and pressure to alleviate illness. As a method of alleviating pain, easing suffering, healing, and even curing a range of illnesses, acupuncture’s origins may go back 4,000 years. Acupuncture manipulation involves the insertion of fusiform thin needles into specific points at an angle into the patient’s body to stimulate the flow of qi and promote healing. According to TCM theory, acupuncture points are located along channels or meridians through which qi flows, and by manipulating these points, practitioners can regulate the flow of qi and restore balance to the body. Twirling and raising are examples of acupuncture procedures that stimulate particular body areas in order to produce the intended therapeutic outcome. Acupuncture treats many conditions, including pain, digestive disorders, respiratory ailments, and emotional imbalances. Widely used across East Asia in various forms, acupuncture has been found by modern Western studies to be effective in relieving certain forms of pain and discomfort.

With the advancement of technology, the stone-needle was replaced with bamboo, and later, metals. Acupuncture treatment is offered in several distinct styles, including Japanese styles, Korean hand acupuncture, Leamington Five-Elements acupuncture, French energetic acupuncture, and Chinese TCM style. There are also specialized approaches, known as microsystems, such as hand–foot acupuncture, and auricular and scalp acupuncture. Although the use of metal needles and moxibustion continues to be the most common technical approach, today, both electricity and lasers are used to replace handheld needles in certain circumstances .

Auricular acupuncture (ear acupuncture, auricular therapy) treats pain and certain diseases by placing needles on the external ear’s specific points. The auricular points are distributed in the pattern of an upside-down fetus. The ear lobe is related to the head and face region, upper extremities are in the scapha region, the lower extremities are in the superior antihelix crus region, and the internal organs are located in the cavum and cymba concha areas .

Fig.7. Representation of ear acupuncture in relation to the inverted fetus.



Pathology, whether on a specific organ or within a body system, is reflected in the auricle, which can exhibit external changes such as discoloration, tenderness and decreased electrical resistance in the corresponding meridian pathway within the ear, and even mild morphological changes (scarring) over time. Auriculotherapy has been shown to be effective in reducing chronic musculoskeletal pain, stress, anxiety and depression, as well as in managing nausea and vomiting in pregnancy . Auriculotherapy has positive effects associated with the conventional treatments of insomnia and chronic and acute pain. Acupuncture points are often characterized as a composite including blood and lymph vessels and nerves of various types, located within a sheet of loose connective tissue (mesenchyme) perforating the superficial fascia separating subcutaneous tissue from muscle. A higher density of gap junctions has been found at the sites coincident with acupuncture points. These gap junctions are hexagonal protein complexes that form channels between adjacent cells, facilitating intercellular communication and increasing electric conductivity . Deep connective tissue structures in locations corresponding to acupoints have been characterized by a higher concentration of Ca, P, K, Fe, Zn, and Mn . It is well known that both Ca2+ and K+ are critical signal mediators playing an essential role in various physiological activities .

Moxibustion (“jiu” or “ai”) is based on burning tinder made of Chinese mugwort (Artemisia argyi or Artemisia vulgaris) next to a locus or on it . Artemisia tinder has come to be known in the West as moxa, a Japanese derivation word (“mogusa”, herb for burning). The classical method of performing moxibustion is to make the tinder into a cone and apply it to the skin at points identical to those used for acupuncture. It could be used as a counter-irritant by blistering and scaring the skin, or as a milder form of heat treatment by applying it to the skin with a layer of vegetable material or salt interposed between the skin and the cone. Another method is to combine moxibustion with acupuncture by placing a piece of moxa on top of a needle inserted into the body and igniting it. Thus, the moxa’s heat is conducted down the needle to the surrounding tissues .

The physiological changes produced by moxibustion are often associated with the combined action of temperature, radiation, and the pharmacological effects of burning Artemisia and its combustion products . The warm temperature of moxibustion induces antipyretic and thermolytic effects by stimulating polymodal receptors in the skin at zones corresponding to acupoints. Vasoconstriction in the treated point and vasodilatation around it are often experienced with increased peripheral blood flow and microvascular permeability. In addition, heat shock proteins naturally synthesized in cells in response to hyperthermia might be induced in local tissues due to the increased temperature.

Nonthermal effects are associated with the visible light and infrared radiation emitted by burning moxa and absorbed by the connective tissue, blood and lymphatic vessels, and nerves, which might induce some active substances such as cytochrome c oxidase and intracellular water, two photoacceptor molecules or chromophores. Changes in the water dynamics in membranes, mitochondria and/or cells could modulate signaling pathways, the production of reactive oxygen species (ROS), ATP (adenosine triphosphate), Ca2+, NO, and inositol phosphates group, with effects on stress signaling, metabolic processes, cytoskeleton organization, cell proliferation/differentiation, and homeostasis. The photoelectric effect and photochemical process generate energy that might help adjust the body’s immune and neurological functions.

The major subproduct of burning moxa is smoke. Studies using solid-phase microextraction gas chromatography–mass spectrometry (SPME-GC-MS) have shown that moxa smoke is composed of furan-structure substances, aromatic compounds, esters, alkanes, and hydroxyl-containing compounds. Although these compounds’ toxicity represents a concern, moxibustion has been considered minimally toxic, safe and effective, with few adverse events . Research has shown that no harmful effects of moxa smoke have been noticed on the heart rate (HR) and heart rate variability (HRV) of treated persons. Nevertheless, excessive inhalation should be avoided due to the increased incidence of chronic laryngitis, as noticed in five Chinese medicine hospitals in the Guangdong province.

Moxibustion has been reported as a successful therapeutic in treating knee osteoarthritis. Research shows that patients treated with moxibustion experience significantly improved pain, stiffness, and physical function compared with sham-moxibustion . The overall outcome of research points to positive effects in managing the symptoms of post-stroke urinary incontinence and constipation, use as an adjuvant therapy for chronic kidney disease , and in treating diabetic peripheral neuropathy.

Cupping is another ancient technique commonly used in TCM. This technique helps the body expel pathogenic factors such as cold or “algor”, dampness or “humor”, and wind or “ventus”, and treats conditions related to the stagnation of “qi” and “xue”, such as bruises or sore muscles. It is beneficial for various pain types in the lower back, shoulders, and legs andt has also been reported as a successful intervention in both usual and emergency treatments, such as herpes zoster, acute asthma episodes, angina pectoris and abdominal pain induced by poisoning .

Cupping is used to move stagnant blood out of deep bruises by bloodletting, and reduce swelling and pain in sprains. Cupping can be done by heating the air within the cupping glass and then putting the cupping glass on the skin. Cooling the air by clapping the cup over the affected area exerts mild suction. The pull exerted pushes the flesh into the cup, mobilizing body fluids into the area . Simple cupping of a point is believed to suck off “humor”, removing excess fluid from the point. Often, this “humor” comes with “ventus” as “humor venti”. Thus, cupping is also used to treat “ventus” .

Cupping can also be performed over the needle to enhance acupuncture effects. The sub-atmospheric pressure inside the cup seems to change the skin’s biomechanical properties, increasing peripheral blood circulation and pain threshold, improving local anaerobic metabolism, reducing inflammation, and modulating the cellular immune system . The comfort and relaxation sensation on a systemic level often reported after cupping might be related to the resulting increase in endogenous opioid production in the brain leading, to improved pain control .

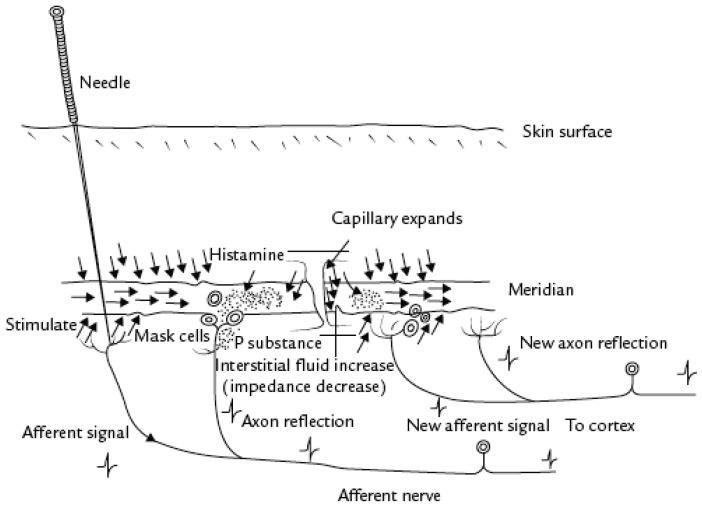


Figure 8. Proposed mechanism for bthe effect of acupuncture along meridians. Copyright 2010 Elsevier (Amsterdam, Netherlands) and Copyright clearance center (Danvers , MA, USA)

Although the origins of Chinese bodywork predate written records, written sources from the Qin Dynasty in the third century BC refer to manual therapy as “Moshou” (hand rubbing). The term “manual therapy” indicates treatment where the hands are used as the primary intervention tool. A century later (Han Dynasty, 206 BC–221 CE), it was called “Anmo” (press and rub), a term still used today. Palpatory techniques for diagnosis and manual treatment techniques are described in the “Huangdi Neijing”.

Many aspects of “Tuina” have come from the martial arts lineage. The bodywork was used to heal traumatic injury and correct structural misalignments, and keep the martial artist fit and healthy . “Tuina” can affect the five sense organs’ health and help a person feel more vivid via hetero or auto treatments, wherein specific self-massage applications play an essential role .“Tuina” (push and pull) and “Anmo” (press and rub) refers to a system of massage, manual acupoint stimulation, and structural manipulation performed by a fully trained practitioner, who combines skills that in the West would usually be divided into massage, physical therapy, osteopathy and chiropractic . A practitioner may also know and incorporate Chinese herbs, plasters, bone setting, and “qi” projection.

Originally, “Tuina” was developed to treat traumatic injury and for use in pediatric care, whereas “Anmo” was directed toward the treatment of internal diseases . A distinct aspect of “Tuina” is the extensive training of the hands necessary for clinical practice. The practitioner’s hands are trained to accomplish focused and forceful movements, applied to several body areas. Techniques such as pushing, rolling, kneading, rubbing, and grasping are practiced until they become second nature. Students practice on a small bag full of rice until their hands develop the necessary strength and dexterity. “Tuina” is often applied to limited body areas.

Fig.9. Examples of Tuina techniques to treat various complaints 

“Tuina” is known as “outer therapy”, and like acupuncture and other techniques, acts on acupoints and structures of the skin. It integrates a vast number of techniques acting on stimulating specific points, muscles and connective tissue, and triggering the reflexes. A typical intervention has three phases:

1. In the activation phase, the meridian is stimulated to remove the build-up more easily;
2. In the intervention phase, the removal of the build-up is performed by specific diagnosis-related techniques;
3. In the harmonization phase, the intervention’s strong effect is normalized with the surrounding tissue’s physiological proportions, and is therefore “harmonized”.

“Tuina” manipulation is experience-dependent, and its therapeutic efficacy is influenced by many operating variables, mainly frequency, duration, and force, which make the standardization process difficult. To identify the standard features of “Tuina” manipulation, the muscle groups involved and their potential cooperation, the motion angle, and the joint forces during manipulation should be considered. It is also essential to quantify the frequency, duration and applied force’s biological effects.

“Tuina” is routinely used in patients with orthopedic and neurological conditions and for treating joint and injury problems, chronic conditions, and back problems . Because these techniques can affect the functioning of the body’s internal organs, they are appropriate for internal medicine, gynecology and trauma, including asthma, dysmenorrhea, chronic gastritis, hypertension, failure to thrive in preterm infants, major depressive disorder, substance abuse and dependence, pain syndromes, and immune and autoimmune conditions. “Tuina” is an adjunct to acupuncture, used to increase the range of motion of a joint, or instead of acupuncture when needles are uncomfortable or inappropriate, such as in pediatric applications.

**“Qigong”**

The term “Qigong” is composed of two words: “Qi”, which was previously explained and could be understood as vital energy or, according to some authors, ethereal dynamic energy with feedback potential , and “gong”, which means the development of capacity. Therefore, “Qigong” is a practice that allows the development of the capacity to collect, circulate and apply vital energy.

“Qigong” integrates three primary schools: medical, martial and spiritual. Although they differ in purpose, they are based on the same philosophical system, sharing several techniques. In essence, medical “Qigong” promotes health, longevity, and the prevention, diagnosis and treatment of diseases and imbalances. Martial “Qigong” focuses on developing the strength and power of martial artists, and spiritual “Qigong” searches for spiritual enlightenment and transformation.

The main therapeutic goals of “Qigong” are :

To eliminate internal pathogenic factors (excessive accumulation of emotions such as anger, sadness, fear, worry) as well as external pathogenic factors (cold or “algor”, heat or “calor”, dampness); several exercises can be prescribed according to the person’s condition, and then performed with the required periodicity.To harmonize the “qi” flow, promoting orthopaty (self-healing power) and avoiding inauspicious depletion (lack of activity) and repletion (excess of activity); , the practitioner uses the so-called “qi emission” techniques to restore balance in the patient. To regulate and balance the patient’s “yin yang” functional status, so as to restore harmony. Distance therapy (also called “qi” emission or external “qi”) requires the “Qigong” practitioner to manipulate the patient’s “qi” by focusing on the energetic properties of the patients’ channels, collaterals, and points, as well as internal organs, from a distance of several inches, several feet, or even several miles away.

As a therapeutic tool, “Qigong” can be used as a self-regulation practice or a mediated healing intervention. TCM theory considers that the human body generates an external defensive field known as “wei qi”. According to the Heidelberg model of TCM, the defensive “qi” is located outside the conduits, within the tissue. It has its origin in the three functional sections of the body (three burners or “calorics”), and centers on, predominantly, the surface (“extima”), where the pulmonary orb ensures its distribution .

This “wei qi” field is believed to include three external layers of subtle energy (physical, emotional and spiritual), each one connected to one of the three “dantians” and surrounding the physical body. The external “wei qi” field protects the body against external pathogenic factors’ incursions, interacting with the surrounding environmental energetic fields. These may include geomagnetic rhythms, Schumann resonance, shallow frequency electromagnetic radiation, X-rays, cosmic rays, as well as the radiation provided by our technology. Both external and internal pathogenic agents affect the “wei qi” field’s structural formation. Internal factors include repressed emotions such as anger and pain from emotional traumas. Strong non-processed emotions block the regular circulation of “qi”, creating stagnation in the body. The external factors include chronic and severe environmental agents, such as coldness, humidity, dampness, heat and wind.

Physical traumas also affect the “wei qi” field by creating fragilities in the external energetic matrix. These fragilities create vulnerabilities, making it easier for disease-causing pathogens to enter. During “Qigong” practice, the “qi” is captured and absorbed in the lower “Dantian”. The practitioner should idealize and feel this energy extending into the Earth (as an anchor), and the surrounding “wei qi” field increasing and expanding . “Qigong” practice promotes the development and control of “qi”, and its balanced distribution through the body. “Qigong” is considered a traditional vegetative biofeedback therapy that uses postures, movements, and breathing exercises combined with meditation to induce the vegetative stabilization and self-regulation of the body’s biologic systems. The “qi activation” is achieved by breath control and a particular mental state of “awareness”, thereby improving and strengthening the overall state of vegetative regulation (homeostasis) .

The “Qigong” practice consists of specific techniques that use knowledge of the body’s internal and external energy fields to purge, invigorate, and balance these energies. Medical “Qigong” therapy offers patients a safe and effective way to rid themselves of pathogenic agents, such as painful emotions that otherwise can cause mental and physical illness. This therapy can be combined with breathing techniques with movement, creative visualization, spiritual intent to improve health, personal power, and control.



Fig.10. Qigong exercises. Sequence a-g: a: focus on the lower dantian, b-e: moving the qi f: White ball lower dantian g: White ball middle dantian sequence h: Taiji qigong pushing palm, ı,j: Taiji Qigong spreading the wings.

Breathing control is particularly important in “Qigong” practice. The breath is the most important source of “qi”, related to the Metal Phase (rhythmical distribution of energy) and the pulmonary “orb”. Breathing is the pacemaker of several vegetative functions, such as the muscular tonus and the capillary blood flow. “Qigong” breathing exercises (“Tu Gu Na Xin”—“expel the old and absorb the new”) promote the capture and absorption of “qi” from the air, increasing the body’s vitality and the harmony between “qi” and “xue”, while promoting health and purging disease. As part of the “orbs”, breathing patterns are directly connected to the five primary emotions significantly affecting the “qi” circulation. Breathing is a connection between mind and body, with effects on physiological functions and emotional balance. Anger or “Ira”, which belongs to the Wood Phase, increases the “qi”, making the exhalation more vigorous than the inhalation. Sadness, grief and pain (“maeror”), which belong to the Metal Phase, deplete the “qi”, making the inhalation more substantial than the exhalation.

Fear and shock (“pavor”), which belong to the Water Phase, decrease and disperse the “qi”, inducing a short and superficial breath, as a result of the kidney’s incapacity to retain the “qi”. Excitation and luxury (“voluptas”), which belong to the Fire Phase, induce irregular breathing with fast-shifting patterns. Worry (“solicitude”) and reflection (“cogitation”), which belong to the Earth Phase, block the “qi” and make the inhalation short and weak, which is sometimes sustained during a period, followed by fast inhalation and exhalation .

One of the prime benefits of “Qigong” is stress reduction, and one of the main concepts of this practice is to use the mind to guide activation and deactivation patterns by imagination. Excessive stress may negatively impact a person’s health state and may be associated with increased anxiety, psychological disorders, and functional impairments of the organs within the body. It has been shown that “Qigong” and “Taijiquan” training may reduce emotional exhaustion, depersonalization, and even improves anxiety, and reinforce attention and effectiveness in high school students .

The “White Ball” is one specific type of “Qigong” similar to the “Zhan Zhuang” system. Children quickly learn this system when enrolled in a formal training program, with evident development of their individual vegetative skills and reduced anxiety-induced effects Infrared thermography can be used to measure the dynamic changes of temperature in the hands during “Qigong” practice.

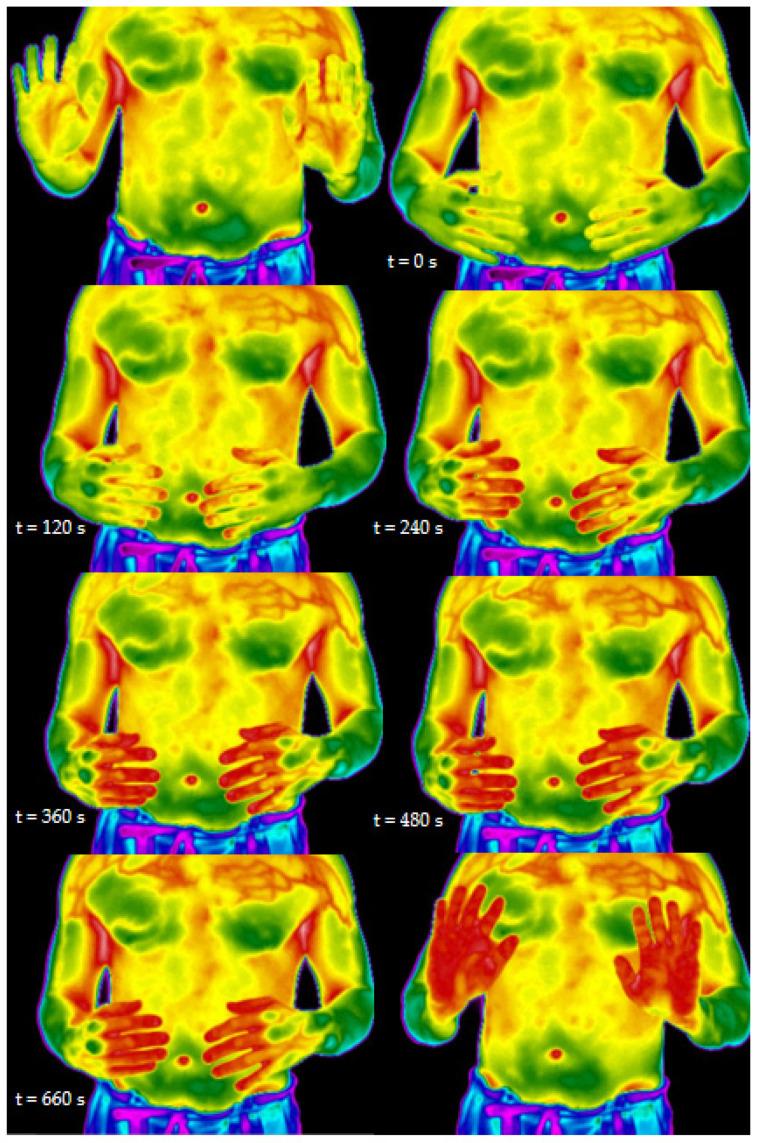


Fig.11. Thermograms of qigong exercise known as White ball. Copyright 2019 Elsevier (Amsterdam, The Netherlands) and copyright Clearance center (Danvers , MA; USA)

Thermography measurement showed that the “Qigong” exercise could change the fingers’ temperature. Therefore, skin temperature changes may be interpreted as an increase in microcirculation. Researchers found that when a particular mental state of awareness was achieved, and the “qi” sensation was felt, skin temperature increased to 37 °C. These data may also help demystify Chinese medicine, while thermography allows for visualizing the microcirculation effects on the hand’s temperature during “Qigong” practice. TCM holds that the “mind” guides the “qi”, which therefore guides the “xue” (“blood”).

Hypertension is a worldwide transversal concern, especially in the elderly population, as aging may decrease the blood vessels’ elasticity and increase the risk of other hypertension-related comorbidities, such as obesity, diabetes and kidney disease. Other common diseases treated by “Qigong” include diabetes, arthritis, hypertension, breast and ovary cysts and tumors, migraine, fibromyalgia, insomnia, acute abdominal pain, colitis, muscular atrophy, brain tumors, stroke, coma recovery, and certain types of cancer. TCM therapeutic success is dependent on the accuracy of the diagnosis. TCM diagnosis is an intricate art dealing with evaluating a matrix of variables, some of them subtle and dependent on the practitioner’s experience and sensibility. Generally, the diagnosis involves looking, listening, palpating and questioning, to establish a general picture of the patient’s condition, involving subtle and physical factors related to their inner nature, their pathological activity and their physiological status. By looking at the patient, the practitioner evaluates the brightness of the eyes, the facial complexion, the body structure and motion, the skin, the hair and the tongue. Listening involves listening to the patient’s breathing, the characteristics of the voice and coherence of the speech, and palpating involves palpating the pulse at the radial arteries on each wrist and pressing the alarm points in the body.

Examples of questioning involve asking the patient about causes, onset, duration, symptoms, previous treatment results, appetite, diet, energy, memory, mood, liquid and solid excretions, and sleep. Although some of the previous variables seem to be easy to gauge and common to Western medical diagnosis, others, such as TCM pulse diagnosis, are complex, skill-dependent, and based on TCM physiological concepts. Pulse diagnosis involves feeling the pulse at the radial arteries of both wrists, in three gauging sites, at two or three depths, individually or simultaneously, depending on the practitioner’s training and experience. The diversity of pulse qualities felt by the practitioner includes, but is not limited to, replete, moderate, weak, floating, stirred, intermittent, racing, sunken, dissipated, hollow, slow, rapid, surging, fine, vacuous, long, short, slippery, rough, string-like, tight, soggy, faint, drum skin, firm, bound, skipping and hidden. This represents an obvious challenge in research, as mainstream science demands the accurate parameterization and standardization of procedures and protocols to promote reproducibility and validate results. TCM standardization requires a rational communicable theory and language that translates to Western physiology the structural concepts of TCM, making possible the inherent rational use of the reflex therapeutic systems, anti-inflammatory mechanisms, and mental training involved. (80-82).

**HOMEOPATHY**

Homeopathy (from Greek Homoios, meaning similar, and pathos, meaning suffering) is a system of medicine whose first tenet is the principle of similars: A substance that can cause symptoms in a healthy person possibly can stimulate self-healing in a person with an illness presenting similar symptoms.

This principle has been developed into a system of medicine in the nineteenth century by the renowned German physician Hahnemann, who published “Essay on the New Curative Principle,” In 1796. Homeopathy originally was based on the *vitalistic theory*. Similar to Ayurveda and traditional Chinese medicine, homeopathy emphasizes the self-healing potential of the human body and a close mind/body connection. It is based on a premise that illness is a result of an imbalance of one's *vital force*, or essential energetic makeup. A correctly prescribed remedy leads to a restoration of the balance and ultimately to cure. This focus on the individual's fundamental energy. Homeopathy essentially rests on two scientific tenets: the principle of similars and a claim concerning the biologic effects of high dilutions. Despite the principles' apparent contradictions of *common sense* in medicine and a clear mechanism of action in physics, careful examination shows that they actually are compatible with many current common biomedical observations.

The description of symptoms in the homeopathic book on pharmacology called *Materia Medica* is based on toxicology of the substance elicited mainly by the process called *proving* (from German *Prüfung*, meaning *test*) or descriptions of accidental poisoning. The first proving was performed by Hahnemann. He took repeated doses of diluted *China* (quinine) in an attempt to understand the origin of its efficacy in the treatment of malaria. To his surprise, he developed symptoms similar to malaria. (83)

**UNANI MEDICINE SYSTEM**

The Unani System of Medicine is based on Hippocatic theory of four humours viz. blood, phlegm, yellow bile and black bile, and the four qualities of states of living human body like hot, cold, moist and dry. They are represented as earth, water, fire and air, in arabic as seven principles (Umoor-e-Tabbiya) including, element (Arkan), temperament (Mizaj), humours (Akhlat), organs (Aaza), sprit (Arwah), faculties (Qowa) and functions (Afaal). In this system is it believed that, these principles are responsible for the body constitution and its health, as well as, diseased conditions .

The World Health Organization (WHO) has recognized the Unani System of Medicine (USM) as an alternative system to cater the health care needs of human population. Unani is still popular in many Arab and East Asian countries. The disease state is caused by the derangement of temperament or humor and retention of health is carried out by applying the various measures to render balance in the polar dimensions of six essential prerequisites of health. The applied aspect of USM deals with the various measures to maintain or restore health .

The principal sources of drugs in USM are,

1. Plant origin drugs

2. Animal origin drugs

3. Mineral origin drugs.

Crude drugs when used one at a time is called Ilaj bil Mufrad (treatment by single drug). When two or more than two drugs are combined together, it is called Ilaj bil Murakkabat (treatment by compound drugs).. Various drug formulations are used in Unani medicine. Dosage forms are used for (Various poly-herbal formulations are manufactured with the help of the process as described by the reference books called The Quarabadeen (pharmacopeias) which has got information related to the number of herbs, quantity used, and preparation of bases and powder size of each constituent. Along with these standards, the dosage and use has been enumerated. The standard preparation usually is used fresh and the time period of its use is generally given. Certain preparations are to be stored up to 6 months so as to stabilize them and the practitioners can then only use them. (85)

**SHAMANIC HEALING**

Ancient healing practices have long been integral to human societies, playing a significant role in addressing health and wellness long before the advent of modern medicine. These ancient traditions encompass diverse approaches, ranging from shamanic rituals to the systematic methods of Hippocratic medicine. Despite the passage of millennia and the advancement of scientific knowledge, these ancient healing practices continue to profoundly influence contemporary healthcare systems, shaping medical philosophies, treatment modalities, and approaches to wellness.

Shamanism represents one of the earliest forms of healing practice, dating back tens of thousands of years. Shamanic healers, known as shamans, served as spiritual intermediaries, navigating the supernatural realms to diagnose and treat illness. Utilizing a combination of rituals, herbs, and spiritual connection, shamans addressed not only the physical symptoms of disease but also the underlying spiritual and emotional imbalances believed to contribute to illness.  Shamanic healing traditions varied widely across cultures, from the indigenous peoples of the Americas to the tribes of Siberia and Africa, yet shared common themes of interconnectedness with nature and the unseen forces that govern the universe. Ancient civilizations developed their medical systems parallel to shamanic healing, often intertwined with religious beliefs and practices.

In ancient India, Ayurveda emerged as a holistic system of medicine, emphasizing the balance of mind, body, and spirit. Ayurvedic texts, such as the Charaka Samhita and the Sushruta Samhita, detailed diagnosis, treatment, and prevention principles, including herbal remedies, dietary guidelines, and yoga practices.  During the Classical period, the work of physicians like Hippocrates and Galen made significant contributions to the development of medical science. Hippocratic medicine, named after the renowned physician Hippocrates, emphasized rational observation, naturalistic explanations for disease, and ethical principles guiding medical practice.

The Hippocratic Corpus, a collection of texts attributed to Hippocrates and his followers, laid the foundation for clinical medicine, advocating for the systematic study of symptoms, prognosis, and treatment outcomes.Galen, a prominent physician of the Roman Empire, further expanded upon Hippocratic teachings, contributing to advancements in anatomy, physiology, and pharmacology.  The legacy of ancient healing practices extends far beyond historical curiosity, influencing contemporary approaches to healthcare and wellness.

In recent decades, there has been a growing recognition of the value of integrating traditional healing modalities into mainstream medical practice, particularly in holistic and complementary medicine. Practices such as acupuncture, herbal medicine, and mindfulness meditation, rooted in ancient healing traditions, have gained acceptance as effective adjuncts to conventional treatments for a wide range of conditions, from chronic pain to mental health disorders.

Socioeconomic factors, cultural attitudes, and regulatory barriers often hinder the integration of traditional healing modalities into mainstream healthcare systems. Additionally, issues of cultural appropriation and commercialization raise ethical concerns about the commodification of indigenous knowledge and practices. Nonetheless, efforts to bridge the gap between traditional and modern medicine continue, driven by a growing recognition of the value of diverse healing traditions in promoting health equity and holistic well-being.

Shamanism, a term derived from the Tungus people of Siberia, encompasses diverse spiritual and healing practices in cultures worldwide. Shamanism is one of the oldest forms of human spirituality and healing in prehistoric times, predating organized religions and formal medical systems.

At its core, shamanism revolves around the belief in the existence of a spiritual realm inhabited by guiding forces, ancestors, and supernatural beings, with shamans serving as intermediaries between the human and spirit worlds. The origins of shamanism are shrouded in the mists of prehistory, with archaeological evidence suggesting that shamanic practices may have emerged as early as the Upper Paleolithic period, over 30,000 years ago. Cave paintings, rock art, and artifacts found in regions such as Europe, Asia, Africa, and the Americas provide tantalizing glimpses into the spiritual beliefs and practices of ancient hunter-gatherer societies, many of which bear striking similarities to modern shamanic traditions. The figure of the shaman is central to shamanism, an individual believed to possess special powers of healing, divination, and communication with the spirit world.

Shamans undergo rigorous training and initiation rites, often involving periods of solitude, fasting, and visionary experiences induced through the use of psychoactive plants or techniques such as drumming, chanting, or dance. Shamans enter altered states of consciousness through these practices, enabling them to journey into the spirit world to seek guidance, retrieve lost souls, or perform healing rituals. The role of the shaman varies widely across cultures, reflecting the diverse beliefs and practices of different indigenous societies.

In some cultures, such as the Inuit of the Arctic or the Aboriginal peoples of Australia, shamans play a central role in hunting, healing, and maintaining harmony with the natural world.  Among the indigenous tribes of the Amazon rainforest, shamans known as ayahuasqueros administer ayahuasca, a powerful psychedelic brew, as a sacrament for spiritual insight and healing. In Siberia and Central Asia, shamanic traditions persist among the Tungus, Yakut, and Mongolian peoples, where shamans known as “tengeri” or “böö” continue to practice their ancient rites.

 Shamanic healing encompasses various techniques to restore balance and harmony to the individual and the community. Central to shamanic healing is the concept of soul loss, believed to occur when a person experiences trauma, illness, or spiritual disconnection. Shamans diagnose and treat soul loss through rituals such as soul retrieval, in which lost fragments of the soul are recalled and reintegrated, or spirit extraction, in which harmful energies or entities are removed from the body. In addition to soul healing, shamans often employ herbal medicine, ritual purification, and symbolic acts to promote physical, emotional, and spiritual well-being.Sacred plants such as tobacco, peyote, and ayahuasca are used in shamanic ceremonies for their healing properties and ability to induce altered states of consciousness conducive to spiritual insight and transformation. Rituals such as sweat lodges, vision quests, and sacred dances are powerful means of communing with the spirit world and accessing hidden realms of knowledge and wisdom.

Despite centuries of colonialism, persecution, and cultural assimilation, shamanism continues to endure in many parts of the world, adapting to changing social, economic, and environmental conditions. In the face of globalization and modernization, indigenous peoples are reclaiming and revitalizing their traditional spiritual and healing practices, asserting their cultural identity and sovereignty. Organizations such as the Society for Shamanic Practice and the Foundation for Shamanic Studies promote cross-cultural dialogue, education, and research into shamanic healing methods, fostering greater understanding and appreciation for this ancient tradition. Before the emergence of Hippocratic medicine, ancient civilizations developed diverse medical traditions that laid the foundation for subsequent advancements in healthcare. These early medical practices encompassed various therapeutic modalities, including herbal remedies, surgical procedures, and spiritual healing rituals. (86-87)

**MEDİCİNE İN ANCİENT INDİA**



Fig.12. Susruta, famed surgeon of old India, depicted preparing a patient for artificial ear lobe operation (otoplasty)

India has one of the world's oldest medical systems, known as Ayurvedic medicine (Ayurveda). This word is a combination of two words. Ayu, a Sanskrit word means life (from birth to death) and Veda means knowledge or science. Thus Ayurveda means science of life.  It has evolved in India over thousands of years. Ayurvedic medicine integrates the balance of the body, mind, and spirit. It is based on theories of health and illness and on ways to prevent and promote wellness, and manage or treat health problems. As in other primitive societies, early Indian society punished wrongdoers with physical mutilation. Cutting off the nose was the usual punishment for adultery. Susruta has developed the technique of nose restorations.

Ancient India was a rich nation in terms of knowledge, wisdom and wealth. The medical practice of ancient Indians is many thousand years old. Ayurveda is the most ancient system of Indian medicine. The knowledge of medicine was spread among sages, hermits and medicos who roamed from place to place. Those who practiced solely this art were called Vaidyas who specialized in medicine or surgery. All ancient civilizations of the world developed their own medical systems, but the ancient Indian system of medicine is considered to be the oldest medical system in the world. An analysis of the material in the Vedas revealed that all the four Vedas had references regarding various aspects of medicine. Plants and their products were the main substance used in composition of medicines by the Vedic healers. Other materials included cow’s milk and its products, water, soil from various sources and rock salt. Ayurveda Vedic period laid the foundation of the Indian medicine system known as Ayurveda. The Ayurvedic principles combine the elements of nature known as Pancha Mahaboota; Vayu (air), Jala (water), Aakash (space), Prithvi (earth), and Teja (fire) . The fundamental rule of Ayurvedic treatment contains two basic parts: to keep the reason for illness and to make the patient more mindful about the reason for sickness. It explains what is appropriate and what is inappropriate in relation to life.

Atharva-Veda, precursor of Ayurveda andthe earliest historical references to healing in India go back to the age of Vedas and contains 114 hymns devoted to medical topics like fever, consumption, wounds, leprosy, heart disease, epilepsy and insanity, eye and ear diseases etc. The treatment of disease (Chikitsa) in Atharva Veda is religious and ritualistic emphasizing such practices as the sacred uttrences (Mantra), penances (Niyama), sacred oblations (Mangalahoma), fasting (Upavasa) and purification rites (Prayaschitta). The Atharva Veda also contains material about human anatomy, herbal medicines and classification of disease. Ayurveda is considered to be the Upaveda of Atharva Veda. The earliest corpus of medical works is embodied in the *Atharvaveda*, transmitted from antiquity in oral form. Atharvaveda contains sections that discuss longevity, treatment of ailments, cures for specific diseases, eradication of germs, antidotes to poison, prudent food habits and healthy lifestyle As exemplified in Patanjali's *Yoga Sutras* (fountainhead), exhorting good thoughts, good works, *asanas* (yoga poses), *pranayama* (control of breathing process), and meditation to attain healthy body and mind, and  *Samadhi* (meditative contemplation to attain higher consciousness). Philosophical notions coexisted with medical knowledge with no conflict. The roots of *Ayurveda* are in Atharvaveda, viewing ill-health as due either to unwholesome lifestyle, or due to *Karmaphala* (fruits of deeds committed).

The Atharva Veda mentions five classes of diseases:

1. diseases produced by wind, water, and fire, later classified in Ayurveda as diseases related to the three Doshas: Vata, Pitta, and Kapha;
2. diseases caused by possession by demons and evil spirits;
3. diseases due to worms;
4. diseases due to sorcery (the use of magic powers derived from evil spirits);
5. hereditary diseases (Kshetraja)

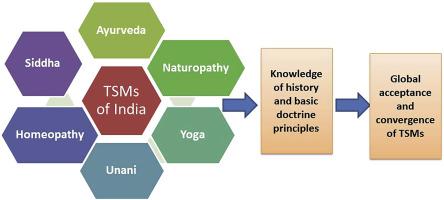


Fig. 13. Tradiitonal Medicine of India.

[Ayurveda](https://www.sciencedirect.com/topics/medicine-and-dentistry/ayurveda) has an age old history since the 2nd Century BC. Its foundations laid by the ancient schools of Hindu Philosophical teachings named *Vaisheshika* and the school of logic named as *Nyaya* related to the manifestation framework, well-known as *Samkhya*.The *Vaisheshika* School preached about inferences and perceptions that should be obtained about a patient's pathological condition for treatment. Whereas, *Nyaya* school propagated its teachings on the basis that one should have an extensive knowledge of the patient's condition, and the disease condition before proceeding for treatment.

The school of *Vaisheshika*, classifies the attributes of any object into six types: substance, particularity, activity, generality, inherence and quality called as Dravya, Vishesha, Karma, Samanya, Samavaya and Guna respectively, in Sanskrit language.  Later, *Vaisheshika* and *Nyaya* schools worked together and jointly founded the *nyāya–vaiśeṣika* school.

The origin of Ayurveda goes to the Hindu God, Brahma ,the creator of the universe, who passed on the holistic knowledge of healing onto the sages for the well-being of mankind. From the sages the knowledge of [traditional medicines](https://www.sciencedirect.com/topics/medicine-and-dentistry/traditional-medicine) was passed on to the disciples and then to the common man by various writings and oral narrations. The information about the healing properties of the herbs was composed in the form of poems, called “*Shlokas*”, which were used by sages to describe the use of medicinal plants.

The Hindu system of healing is based on four eminent compilations of knowledge (*Vedas*) called as *Yajur Veda*, *Rig Veda*, *Sam Veda*, and *Atharva Veda*. The *Rig Veda* is the most well-known of all the four Vedas and describes 67 plants and 1028 Shlokas. The *Atharva Veda* and *Yajur Veda* describe 293 and 81 medicinally useful plants. The practice of Ayurveda is based upon the knowledge gained from these Vedas. The compiled knowledge from the Vedas, was edited by Charaka and is called as “*Charaka Samhita*”.

Ayurveda believes that the entire universe is composed of five elements: Vayu (Air), Jala (Water), Aakash (Space or ether), Prithvi (Earth) and Teja (Fire). These five elements (referred to as *Pancha Mahabhoota* in Ayurveda) are believed to form the three basic humors of human body in varying combinations. The three humors; *Vata dosha*, *Pitta dosha* and *Kapha dosha* are collectively called as “*Tridoshas*” and they control the basic physiological functions of the body along with five sub-doshas. Ayurveda believes that the human body consists of *Saptadhatus* (seven tissues) *Rasa* (tissue fluids), *Meda* (fatandconnectivetissue), *Rakta* (blood), *Asthi* (bones), *Majja* (marrow), [Mamsa](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/amsacrine) (muscle), and *Shukra* (semen) and three *Malas* (waste products) of the body, viz. *Purisha* (faeces), *Mutra* (urine) and *Sweda* (sweat).

*Vata dosha* maintains the cellular transport, [electrolyte balance](https://www.sciencedirect.com/topics/medicine-and-dentistry/electrolyte-balance), elimination of waste products and its effect is increased by dryness. *Pitta dosha* regulates the body temperature, optic nerve coordination and hunger and thirst management. Heat conditions of the body aggravate *Pitta*. *Kapha dosha* is increased due to sweet and fatty food and it provides lubrication to the joints for proper functioning. The catabolism of the body is believed to be governed by *Vata*, metabolism by *Pitta* and anabolism by *Kapha*.  For a healthy state of health, a balance between the three doshas and other factors should be maintained. Any imbalance between the three causes a state of illness or disease  In Ayurveda, a perfect balance between the nature elements and the Tridoshas of the human body should be maintained for a healthy state of living by following the principles of divine wisdom.

 The body is believed to be composed of seven types of tissues called as “*Sapta Dhatus*”. These seven tissues work in coordination for proper physiological functioning of the human body. The *Rakta Dhatu* resembles the blood and regulates the circulation of blood cells and provision of blood components to the body. The *Mamsa Dhatu* (Muscle tissue) provides supports in the form of [skeletal muscles](https://www.sciencedirect.com/topics/medicine-and-dentistry/skeletal-muscle) for the *Meda Dhatu* (adipose fat). The *Asthi Dhatu* comprises the bones of the body and the *Majja Dhatu* is made up of the bone marrow and fluids required for the oleation of the bones and their functioning. The *Shukra Dhatu* is responsible for functions of the [reproductive organs](https://www.sciencedirect.com/topics/medicine-and-dentistry/reproductive-organ) of the body. Apart from the Doshas and the Dhatus, the other important factors considered in the doctrine of Ayurveda are the *Tri Malas* and *Trayo Dosa Agni*. *Tri Malas* are the three types of waste products formed in the body due to metabolic and [digestive functions](https://www.sciencedirect.com/topics/medicine-and-dentistry/digestive-function) of the body. They comprise of the Mutra (urine), Purisa (faeces), and Sveda (sweat).

Ayurveda explains that if the balance between Tridosha is not maintained the waste products of the body are not effectively eliminated and these lead to further complications like diarrhea, constipation, asthma, [rheumatoid arthritis](https://www.sciencedirect.com/topics/medicine-and-dentistry/rheumatoid-arthritis) and such other complications. If the *Mutra Mala* (urine) is not removed from the body, it can lead to [urinary tract infections](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/urinary-tract-infection), [cystitis](https://www.sciencedirect.com/topics/medicine-and-dentistry/cystitis) and gastric pain. If the *Sveda Mala* is not cleared from the body, it can lead to [skin irritation](https://www.sciencedirect.com/topics/medicine-and-dentistry/skin-irritation) problems, and improper fluid balance. As per the principles of Ayurveda the biological fire of the body for all the metabolic function is called as “*Agni*”. There are thirteen categories of *Agni* in a human body and the most important is the one responsible for digestive fire, called as *Jatharagni*. *Jatharagni* has a close relation with *Pitta* and ultimately *Vatta* of the body. If the digestive fire of the body is increased in the body by increase in acidity conditions, the elevation in *Pitta* levels and its relative symptoms are observed. Digestive fire is important in controlling the normal [microflora](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/microflora), proper digestive functions and provision of energy to the entire body. Any disturbances in its balance, creates discomfort to the gastro-intestinal tract and results in pathological complications like ulcers, diarrhea and constipation.

Considering the bodily constitution, pathological history, the Dosha characteristics, life style and environmental conditions in an individual's routine life style, Ayurveda has many treatment strategies for promoting well-being to individuals.

*Ayurveda* employs the “*Pancha karma*” method in its therapies. *Pancha karma* therapy applies various processes for the [rejuvenation](https://www.sciencedirect.com/topics/medicine-and-dentistry/rejuvenation) of the body, cleansing and enhancing longevity. The *Pancha karma* is composed of five karmas (actions) that are used for removal of toxins from the [body tissues](https://www.sciencedirect.com/topics/medicine-and-dentistry/tissue-anatomy). They are the *Virechan* (purgation though use powders, pastes or decoction), *Vaman* (forced therapeutic emesis by use of some medicines), *Basti* (use of enemas prepared from medicated oils), *Rakta moksha* (detoxification of blood) and *Nasya* (administration of medicines like decoctions, oils and fumes through nasal route).Primarily, *Pancha karma* consists of 3 steps. *Poorva karma* (preparatory process of the body for the therapy), *Pradhan karma* (the main process of therapy) and the *Paschat karma* (consisting of regimens to be followed to restore digestive and other absorptive procedures of the body, back to the normal state).

Clarified butter and medicated oils are used in the oleation process. Swedan (sweating) is brought about by exposure to steam for particular areas of treatment of the body. Forced emesis or *vamana* is brought about by administration of [decoction](https://www.sciencedirect.com/topics/medicine-and-dentistry/decoction) of [liquorice](https://www.sciencedirect.com/topics/medicine-and-dentistry/glycyrrhiza-glabra-root), honey with a few hours of prior administration of curd and rice. These substances are believed to cause elevation in the emesis effect. The Virechana, or laxative therapy is carried out by administration of herbs and liquids like [senna](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/senna), [cow milk](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/dairy-cattle), [psyllium seed](https://www.sciencedirect.com/topics/medicine-and-dentistry/psyllium), and [castor oil](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/castor-oil). The enemas used in Pancha karma can be prepared from medicated oils or decoction of herbs like [sesame](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/sesame) or anise. In practice, Ayurveda has eight disciplines called as “*Äshtanga Ayurveda*”. They are *Kayachikitsa* (internal medicine treatment), *Bhootavidya* (treatmentofpsychologicaldisorders), *KaumarBhritya* (pediatrictreatment), *Rasayana* (studyofgeriatrics), *Vajikarana* (treatmentthrough [aphrodisiacs](https://www.sciencedirect.com/topics/medicine-and-dentistry/aphrodisiac) andeugenics), *Shalya* (surgical treatment), *Shalakya* (otorhinolaryngological and ophthalmological treatment), *Agada Tantra* (toxicological studies).

The ***Siddha*** system of medicine is based upon the principle similar to Ayurveda considering that the human body is constituted from the five elements of the Universe like the pancha mahabhootas. Along with these elements Siddha system considers that the physical, moral and physiological well-being of an individual is governed by 96 factors. These 96 factors include perception, speech, diagnosis of pulse etc. Perception determines the treatment of psychosomatic system with the help of minerals, metals and to a lesser extent some plant products. Siddha system uses many preparations of plant and mineral origin in powder form, prepared through various procedures including calcinations.[https://www.sciencedirect.com/science/article/pii/S2225411016000250](https://www.sciencedirect.com/science/article/pii/S2225411016000250#bib23) Through its therapies and diagnosis based on pulse and analysis of *Tridosha* state of an individual, yoga suggests meditative exercises and life style management to obtain tranquility and improve health.[https://www.sciencedirect.com/science/article/pii/S2225411016000250](https://www.sciencedirect.com/science/article/pii/S2225411016000250#bib25) The Asanas (postures) of Yoga are applied in various clinical and nonclinical conditions for curing various physical and emotional conditions.

According to the therapeutic principles of Ayurveda focusing on *prakriti* and *tridoshas*, every individual has unique constitution called as *prakriti*, that determines the characteristic response of each individual to medications, environmental conditions and dietary factors. ‘Ayurgenomics’ a recently introduced research field, bridges this gap between genomics and Ayurveda and serves as an aid in understanding of inter-individual differences in responses to therapies in various diseases. It especially emphasizes on studying inter-individual variances in patients from identical ethnic backgrounds.

Ayurveda viewed the human health in terms of three *doshas* (fundamental energies orgoverningprinciplesofbody)comprising5elements  *Vata* [air *(Vayu)* + space/ether *(Aakash)*], *Pitta* [fire *(Agni)*], and *Kapha* [earth *(Prithvi)* + water *(Jala)*], imbalance of which gave ill-health, and sought correction to the ideal. The universe was considered composed of the *Pancha Mahabhootas* (5 great elements) and the physiological functions controlled by the doshas. The human body was defined as comprising *saptadhatus* (7)fundamentalprinciples/tissues)  *Rasa* (tissuefluids), *Rakta* (blood), *Mamsa* (muscle), *Meda* (fat), *Asthi* (bones), *Majja* (marrow), and *Shukra* (reproductive tissue).

 Praying to divinities for healing and for good health was common in northern India by worshiping Sheetala Mata or Ma Durga, and in southern India by worshiping Mariamman. The iconography presents Sheetala Mata carrying a broom and carrying pots, illustrating the importance of cleanliness; the water was kept stored in bronze or copper pots for its antiseptic properties as was the use of herbal healing powers of turmeric and neem leaves.The early evidence of medical practices in India can be traced through the archaeological finds. A 9000-year-old tooth was found in Baluchistan with apparent drilling to remove rotten dental tissue, and several skulls were recovered from Mehrgarh and Harappa Cemetery dating to 2300 BCE showing trepanation and the bone healing. In yet another find, near Baluchistan in the Burnt City dating to 2800 BCE, a skeleton with a bitumen prosthetic eye was retrieved from a grave.

The use and construction of surgical instruments has been found in the medical compendium, Sus'ruta *Samhita* (code of practice), unsatisfactorily dated variously between 600 and 200 BCE by Western scholars. Surgical instruments made of copper were recovered from Taxila dating to this early period. One of the earliest extant scripture of Indian medicine was recovered from the Xinjiang province, the Bower Manuscript – a birch bark document written in *Gupt Prakrit* (a vernacular), from about 200 CE. Ancient books such as Sus'ruta Samhita has 120 chapters in 5 sections, where it discusses anatomy, physiology, pathology, pharmacology, diagnostic medicine, pediatrics, geriatrics, obstetrics and gynecology. Sus'ruta describes human anatomy in details and discusses 1120 diseases and surgical methods including excision, incision, suturing, scraping, puncturing, blood-letting, probing, extraction, rhinoplasty, and cataract surgery, and describes 121 surgical instruments.

It is believed that the old European terms describing the ***Heart*** took their roots in the Sanskrit word- *Hridaya.* The search in English encyclopedia for the origin of the word-heart lead to *heorte* that meant breast, soul, spirit, will, desire, courage, mind and intellect. It could also be connected to Proto-Germanic *hertan,* old Saxon *herta,* old Frisian *herte,* old Norse *hjarta,* Dutch *hart,* old high German *herza,* German *Herz,* and Gothic *hairto.* Spelling with -ea- could reflect to origin before c.1500, since a long vowel, spelling was retained when the pronunciation shifted. Most of the modern figurative senses were present in old English, including the notion of heart as the seat of inmost feelings, emotions, love and affection, or courage from late 14c.

The *Sanskrit* word, Hridaya was derived from 3 verbs as per Satpath Brahman and Brihadaranyak. (i) **HRU** for *harati* i.e. to receive from or to abduct, (ii) **DA** for *dadati* i.e. to give or to donate, and (iii) **YA** for either *yagati* i.e. to control through self-generated rhythmicity, or *Yama* i.e. maintaining balance for contraction and relaxation, or to circulate. Therefore, the word hridaya in itself was a comprehensive physiologic expression. The concept of hridaya was illustrated in Charak Samhita within the chapters including *Arthe Dash Mahamully Adhyaya* and *Trimarmiya Adhyaya*. The hridaya was described as the organ engaged in contraction and relaxation ceaselessly during waking and sleep. Described first in *Atharva Veda,* hridaya was considered as an organ system including *sirasthahridaya* i.e. brain and *urusthahridaya* i.e. heart. *Yogvashishtha* also clearly mentioned a thoracic and a cranial hridaya, and expressed the emotional component of the heart.

Genetically, hridaya was considered a maternal organ that was originated from the essence of *shonita* (feminine genotype) i.e. rakta and kapha. A parallel was drawn between the evolution into a muscular organ similar to that of myometrium. A high mitochondrial content of the myocardium also supports maternal origin. *Shukra* or masculinity genotype, responsible for regenerative function, was not considered an important player; cardiomyocytes are not capable of replication. By the fourth month of pregnancy the evolution of the heart was considered completed and began to work in mother's womb when the mother was referred to as *dvihridaya* (dual hearted).

In the *Garbh Vyakarana* (embryology) *Shariropkramnitya* Adhyaya of *Sharir Sthana* in Sus'ruta Samhita, hridaya was described as a type of *sira-marma* (sira = vessel, marma = vital part) wherein hridaya gave rasa (plasma), rakta (blood) and *oja* (energy/nutrition) through *srotas* (tracts/vessels) to the entire body. Sus'ruta reported hridaya as *Marmasthan*, *Pranayatan* (seat of vitality) or *sadhyapranhar* (a vital organ) based on fatal prognosis of injury to the organ *Kashyapa* referred to hridaya as *mahamarma* (predominant vital organ) similar to Charaka who attributed the supreme vital organ status to hridaya being the seat of *aatma* (soul) and *manas* (spirituality).

When describing the location, Sus'ruta mentioned the hridaya to be situated between the two breasts, in the chest above the mouth of the stomach. About the size of individual's fist, it was described to be shaped as *adhomukhapundrika*, i.e. an inverted lotus with apex directed downwards.  The hridroga were reported due to dysfunction of *vayu* (wind or circulation), especially *prana* (air exchange) and *vyana* (omni present air or circulation) vayu. Hridaya was also associated with *sadhak pitta* (heart-mind balance, consciousness), *avalambak kapha* (i.e. structural integrity of heart and lungs)[38](https://pmc.ncbi.nlm.nih.gov/articles/PMC8514395/#bib38) and *oja* (metabolism or energy distribution).

*Pranavayu* was associated with blood cleansing and acceptance of the rasa–rakta complex in the heart (*aadaan*), valve closure, and generating *praspand* (cardiac impulse). Pranavayu brought *amberpiyush* (oxygen) with every inspiration and *udanavayu* provided *bala* (energy) to cardiac muscles. The latter was accountable for the force required to propel and circulate (vyana) the rasa–rakta complex along the *mahadhamanee* (aorta). Defects of pranavayu and udanavayu could result in enlargement or failing of heart. Sus'ruta described *mandala sandhis* (or the valves) that controlled the unidirectional flow of rasa–rakta complex in and out of the heart. In *amavata* (arthritis) valves could become affected. The *vyanavayu* controlled the rhythmicity of the hridaya as well as contraction and relaxation.[https://pmc.ncbi.nlm.nih.gov/articles/PMC8514395/](https://pmc.ncbi.nlm.nih.gov/articles/PMC8514395/#bib40)

 Vyanavayu was considered responsible for the circulation of rasa–rakta complex from the heart to the body along three directions i.e. upwards (heart to head and back), horizontally (portal circulation) and downwards (peripheral circulation). Samanavayu indirectly influenced the heart by bringing the nutritive fluid from digestive tract to the heart. Sadhakapitta affects rhythmic control of the heart,[https://pmc.ncbi.nlm.nih.gov/articles/PMC8514395/](https://pmc.ncbi.nlm.nih.gov/articles/PMC8514395/#bib41)  the avalambaka kapha accounted for lubrication and could now considered to be associated with pericardial effusion, pleural effusion and pulmonary edema.

Ayurveda, the ancient Indian system of medicine literally meaning “the knowledge of healthy long life”, is concerned with “the ‘total way of life,’ and not just a ‘system of medicine’ that offers to cure diseases through drugs and rituals.” According to the ancient physicians, in the “knowledge of healthy long life,” medicine was not just the medical drugs used in the treatment of illness. “Medicine in their eyes was not a catalogue of makeshift devices to get over disease and re-establish bodily ease, but it was the synthetic facts underlying and regulating the life of the human in its varied physical, physiological and psychical aspects and stages, in a word, the science of life as a whole.”

In the *Caraka-samhita* , it is said that Life (*ayuh*) comes into existence due to the association of the body (*sarira*), senses (*indriya*), mind (*sattva or manas*), and soul (*atma*). The *Caraka-samhiata* and the *Susruta-samhita* “explain the state of health and of disease by the interplay of constituent elements of the organism, of the elementary and general regimes and by the influences of time and season,” and they did not pay much attention to “magic and mysticism” .

The energy flowing through the channels (nadi) carries information about the health of all connected aspects, including organ channels (srotas), tissues (dhatus), organs, their health, and regeneration within the blood. During nadi pariksha, this energy provides insights into our body's metabolism, conscious and subconscious mind, attitudes, experiences (samskaras), and patterns (vasanas) that we have lived through in the past [https://www.qeios.com/read/8D3ZSX](https://www.qeios.com/read/8D3ZSX#NYWzzex18dN0). When an allopathic doctor checks a patient's wrist, they typically only assess the rhythm of the pulse. However, nadi pariksha allows for more detailed observations. In traditional nadi pariksha, three fingers (index, middle, and ring finger) are placed just below the wrist on the radial artery to observe over 28 different pulse attributes. This provides a comprehensive understanding of the patient's health.

The actions of the mind and the five sense organs produce subtle vibrations in the cells, which are carried by the blood to various parts of the body. These vibrations can lead to imbalances in the energies stored in the cell memories, resulting in symptoms such as diabetes, hypertension, hyperthyroidism, cancer, and other physiological symptoms. By identifying the cause and effects of one's actions through nadi pariksha, suitable therapies can be employed to address the underlying causes and effects [https://www.qeios.com/read/8D3ZSX](https://www.qeios.com/read/8D3ZSX#xkboaz4Yelet).The Vedas provide detailed explanations of Krimi (organisms), classifying them into Drishya (macro) and Adrishya (micro), existing in water, earth, sky, and houses. This implies that the Atharvanic people had knowledge of ultraviolet rays present in sunlight. Additionally, it is stated that pathogenic bacteria mostly thrive in darkness and perish at sunrise [https://www.qeios.com/read/8D3ZSX](https://www.qeios.com/read/8D3ZSX#swaFCbFL2zQo).

Ayurveda views human health in terms of three *doshas*, which are fundamental energies or governing principles of the body, comprising the five elements: *Vata* (air - *Vayu* and space/ether - *Aakash*), *Pitta* (fire - *Agni*), and *Kapha* (earth - *Prithvi* and water - *Jala*). An imbalance in these doshas leads to ill-health, and Ayurveda seeks to restore them to their ideal state. According to Ayurveda, the universe is composed of the *Pancha Mahabhootas* (five great elements), and the doshas control physiological functions. The human body is described as comprising *saptadhatus* (seven fundamental principles/tissues): *Rasa* (tissuefluids), *Rakta* (blood), *Mamsa* (muscle), *Meda* (fat), *Asthi* (bones), *Majja* (marrow), and *Shukra* (reproductive tissue).

Table 3.Synonyms and Varieties of Jwara (Fever)

| **S. No.** | **Varieties of Fever** | **Causes** |
| --- | --- | --- |
| 1 | Abhraja | Due to clouds (Kaphaja Jwara) |
| 2 | Vataja | Due to Vitiation of Vata |
| 3 | Shushma | Due to emaciation |
| 4 | Parusha | Due to rukshatwa (dryness) in the skin |
| 5 | Anga | In Limbs |
| 6 | Angabhed | Due to body pains |
| 7 | Sheeta | Due to cold |
| 8 | Roor | Due to Paittik |
| 9 | Trithiyak | Fever manifested on the 3rd day |
| 10 | Vitrithiyak | Fever manifested on the 4th day |
| 11 | Sadandi | Continuous |
| 12 | Sharad | Due to specific effects of autumn season |
| 13 | Varshik | Due to specific effects of rainy season |
| 14 | Grishma | Due to specific effects of summer season |
| 15 | Vishwa Sharad | Spreading type diseases (Malaria due to specific effects of Autumn season) |
| 16 | Aruna | Fever with red-colored pustules, i.e., Masurika (smallpox) |
| 17 | Babhru | Yellow fever |
| 18 | Vanya | Due to forestry |
| 19 | Chyavan | Fever with excessive sweating |
| 20 | Nodan | Intermittent |
| 21 | Avritha | Vishamajwar (Typhoid) |
| 22 | Ghrishnu | Due to injuries or wounds |
| 23 | Hayan | Due to indigestion of Vreehi (a kind of rice) |

Based on various sources, the attributes of the mind are as follows: (i) conscious-unconsciousness, (ii) self-identity, (iii) field-like properties, (iv) energy or power, and (v) immaterial nature through its association with the soul in the physical body.

According to Ayurveda, the following concepts apply: (i) The mind, with its creative potential, was the first entity to come into existence, and everything else was subsequently created. (ii) The physical body is merely a gross, material replica or "image" of the mind, forming the basis of the classical Indian doctrine of "mind-over-matter." (iii) The mind and body exist on an immaterial-material continuum and mutually influence each other.

The present-day concept of psychosomatic medicine is implied in Ayurvedic teachings, which suggest that:

1. Every disease has multiple etiological factors.
2. Every physical disease has one or more psychological factors as etiological agents.
3. The psychological etiological factors include fear, anger, grief, greed, pride, jealousy, etc. It is interesting to note that greed and pride are considered as factors contributing to illness. According to this thesis, none of us are free from susceptibility to illnesses.
4. Certain qualities of living related to values, attitudes, and behavior promote health, including courage, righteous living, and the ability to control one's behavior to ensure righteous living. According to Indian scriptures, "righteousness" encompasses attitudes and behaviors that maximize long-term benefit for all life

Evidence of early medical practices in India can be traced through archaeological discoveries. For instance, a tooth dating back 9000 years was found in Baluchistan, exhibiting signs of drilling to remove decayed dental tissue. Additionally, several skulls were unearthed from the Mehrgarh and Harappa Cemeteries, dating back to 2300 BCE, showing evidence of trepanation and bone healing. Another discovery near Baluchistan, in the Burnt City dating to 2800 BCE, involved a skeleton with a bitumen prosthetic eye found in a grave [https://www.qeios.com/read/8D3ZSX](https://www.qeios.com/read/8D3ZSX#aWGTab397ym1).

A traditional system for health, well-being, healing, and medicine, Ayurveda has been prevalent in India and southern Asia for more than 2,000 years. One of the classic texts that established India’s primary form of traditional medicine—Ayurveda, was the Charaka Samhita, that instructs physicians on how to examine a patient and make a diagnosis, and also recommends treatments. Most of the remedies emphasize lifestyle, hygiene, exercise, and diet, as well as herbal and mineral-based medicines.

While various forms of Ayurveda have developed over the centuries in different regions, most systems are based on the concept of five elements. These elements are water, fire, earth, air, and ether or space. In each person the proportion of these elements varies over time and contributes to the three doshas. The three doshas are wind, bile, and phlegm. Good health and wellbeing occur when the doshas are well balanced. Imbalance brings unease and sickness, related to the dominant dosha. (88-91)

**ANCIENT MESOPOTAMIAN MEDICINE**

Mesopotamian doctors had a professional name: asu or azu, were those who practiced therapeutic medicine, composed of surgical and herbal treatments; the counterpart of the asu were the asipu or ashipu, who practiced divinatory and religious medicine. The text of the Code of Hammurabi (c. 1700 BCE) differentiates religious healers in two classes: diviners, baru, who practiced hepatoscopy and made prognoses, and exorcists, ashipu, who determined what offense to gods or demons had brought about the disease.

Both types of religious healers gave physical examinations to look for telling symptoms. The asu physicians were trained in schools associated with temples of the goddess of medicine and healing, Gula, and were educated using a combination of clay tablet textbooks, the equivalent of rounds, and practical experience; asu focused more on the patients’ accounts of their illnesses than on physical examination like the ashipu. The practices of asu physicians’ services and fees were regulated by law: the Code of Hammurabi . Their states and medical fees were on a sliding scale dependent on one’s social class (awelum were elites, mushkenum were commoners, and wardum were slaves). The Babylonian government had the right to inspect a physician’s work, and that errors of omission or commission were corporally punishable, among other detailed rules. The physicians of ancient Mesopotamia were methodically trained, had facilities and tools to treat patients with both pharmaceutical medicine and surgery, and were an integrated and regulated part of society. Herbal medicine and other pharmaceuticals were ubiquitously used tools of asu physicians in ancient Mesopotamia. Some treatments were based on empirically discovered characteristics of the ingredients used, while others were more based in the attribution of superstitious or symbolic qualities than their effectiveness. A Sumerian cuneiform tablet from c. 3000 BCE details fifteen pharmaceutical prescriptions.

The elements of the treatments are faunal, botanic, and mineral: sodium chloride (salt), potassium nitrate (saltpeter), milk, snakeskin, turtle shell, cassia, myrtle, asafetida, thyme, willow, pear, fig, fir, and date. All parts of plant anatomy were utilized: branches, roots, seeds, bark, sap, and branches. These essential components were administered in vehicles of honey, water, beer, wine, and bitumen, as poultices and internal medicine. Few ingredients were recombined into laxatives, detergents, antiseptics, salves, filtrates, and astringents.

Opiates were another class of botanical medicine that was utilized by the ancient Mesopotamians: narcotics were derived from Cannabis sativa (hemp), Mandragora spp. (mandrake), Lolium temulentum (darnel), and Papaver somniferum (opium).There is evidence that opium poppies were definitely present in Sumeria by 3000 BCE, but they were probably reserved for use by ashipu and priests in healing temples, and they were used in conjunction with hemlock as euthanasia.

In a list of Babylonian healing rituals, pharmaceutical components such as cress, mint, extract of cedar, and date palm, are used in conjunction with invocations. Thousands of treatments that could be created by combining available materials was based on both religious reasoning and trial and error The Code of Hammurabi is a source of information on medical practices. In the treatment of all wounds, there were three critical steps: washing, applying a plaster, and binding the wound.

The ancient Mesopotamians understood and practiced at least the first two of these three steps, extrapolating from the same c. 3000 BCE prescription tablet. They had the technologies of soap-making and distillation. Other texts give detailed instructions for surgery with a scalpel, including post-operative care such as the dressing of operations sites with oilsoaked linen bandages. One scantily described operation was the cutting between the third and fourth ribs, counting from inferior to superior, to relieve pus collection in the pleura or liver. In pre-1000 BCE Mesopotamia there was a well-established profession that included diagnosis, pharmaceutical applications, and the proper treatment of wounds. Asu physicians operated only based on their text-based educations and personal experience without personally falling back on a less experimental concept of disease.

The Babylonian word for physician, asu, derives from the Sumerian a-zu or ia'-zu, meaning 'the man who knows water (or oil)'; presumably relating to divination by water with the aid of the water God Ea [Enki]” . Though the profession of the asu may have had even more ancient roots in the art of divination, by 3000 BCE there were relatively sophisticated medical alternatives to religious healing, as exemplified by contemporary texts that d detail pharmaceutical prescriptions and surgeries.

Medical healers existed from the middle of the 3rd millennium. In line with the strong theocratic state culture, healers were closely integrated with the powerful priestly fraternity, and were essentially of three main kinds: barû (seers) who were experts in divination, âshipu (exorcists), and asû (healing priests) who tended directly to the sick. All illness was accepted as sent by gods, demons and other evil spirits, either as retribution for sins or as malevolent visitations. Treatment revolved around identification of the offending supernatural power, appeasement of the angry gods, for example by offering amulets or incantations, exorcism of evil spirits, as well as a measure of empirical therapy aimed against certain recognised symptom complexes.

Medical practice was rigidly codified, starting with Hammurabi's Code in the 18th century BC and persisting to the late 1st millennium BC. The so-called Diagnostic Handbook, the Assyrian Herbal and Prescription Texts describe the rationale of Mesopotamian medicine, based predominantly on supernatural concepts, although rudimentary traces of empirical medicine are discernible. There is evidence that Egyptian medicine might have been influenced by Mesopotamian practices.

Early in Ancient Mesopotamia’s history (mid-fourth millennium BC), cuneiform records using impressed signs on wet clay were invented. Among these records were many medical prescriptions and a few pharmacological manuals. Around 5000 medical prescriptions have been found in libraries of King Assurbanipal of seventh-century Nineveh, and in temple and private libraries and hoards from other Neo-Assyrian cities and cities of sixth- to third-century Babylonia. First pharmacological texts date to the second half of the third millennium BC, being unearthed at the ancient city of Ebla (located in the Idlib Governarate, Syria). They record nomenclature and lexicographical issues, descriptions of plants, and herbals that link plants with the ailments they alleviate.



Fig.14. the cuneiform records of Ancient Mesopotamia to explore their healing methods.

The cuneiform literature provides evidence that ancient practitioners were competent in curing diseases or complaints, using multiple prescriptions for the same problem. One of the best-documented cuneiform medical sources is a lexicon of drug terms, the Uruanna: maštakal (meaning ‘the plant whose home is heaven is the plant maštakal’). It contains about 1300 terms for drugs of plant origin which. Plants (herbs, trees and bushes, spices, grasses, algae, aromatic plants and fungi) dominated Babylonian healer’s repertoires; many were also common foods (onion, garlic, pomegranate, fig and date). Written records helped practitioners to recognise and collect medicinal plants and to avoid poisonous plants. The main source for plant descriptions was the manual Šammu Šikinšu (meaning ‘the appearance of the medicinal drug’). While medical recipes involved entire plants rather than parts, plant descriptive texts provided more on the parts and their efficacy (roots, stems, leaves, flowers, fruits and seeds) and on plant products (flour, powder, chips and ashes).

Information on sources of medicinal plants comes from letters. One such text records 28 trees, known from other sources to be of medicinal value. This may be significant since pharmacological and medical texts refer to only 35 trees or shrubs used as medicines. A small tablet ascribed to king Marduk-apla-iddina, who ruled Babylon in the eighth century BC, describes 67 plants in his garden, half of which were medicinal.There are references to plant habitat in plant description texts and medical recipes, as well as advice on correct times and methods of harvest. Documents like the drug inventory from Assur, dating from the seventh century BC, describe how medicinal substances could be stored. It lists 177 drugs, of which 159 (about half the known number of drugs from Mesopotamian sources) are of plant origin.

For Babyonians, healing addressed wellbeing in religious, social and psychological terms, while curing meant treatment and removal of illness. They used prayers, exorcism and medicinal substances that influenced certain functions of the body. In medical prescriptions, disease as illness or demon was treated in the same way, indicating that choice of treatment did not depend on religious, magical or natural perceptions of disease. Practitioners responded to the double nature of disease—illness or demon—by using different incantations.

Religious premises lay behind the choice of medicinal plants to treat specific ailments in medical prescriptions. Medical incantations, recited to guarantee the efficacy of both treatment and medication, were recorded. Pains were thought to be caused by a specific disease-demon that was given different names according to the body parts it attacked, while treatment aimed to drive the demon from the body.Disease was not explained as dysfunction of the body or as deviation from its normal state but rather in metaphysical terms, establishing analogies and correspondences between plants and diseases or diseases and deities or other supernatural powers. Some of the metaphysicial analogies were connected with the important healing goddess Gula.

The Sumerians are considered the originators of medication. They used medicines as early as 3,500 B.C. and developed enemas, suppositories, lotions, pills, inhalations, ointments, snuffs, poultices, and infusions. By trial and error, the Sumerians discovered that alkaline substances neutralize the stomach's natural acids and reduce the production of pepsin, which irritates the stomach's lining. The chief ingredient in their stomach relief medicines was sodium bicarbonate (baking soda).The world oldest known prescriptions, cuneiform tablets dating back to 2000 B.C. from Nippur, Sumer, described how to make poultices, salves and washes. The ingredients, which included mustard, fig, myrrh, bat dropping, turtle shell powder, river silt, snakeskins and "hair from the stomach of a cow," were dissolved into wine, milk and beer. Mesopotamians used salt water for gargling, sour wine as a disinfectant, potassium nitrate obtained from urine as an astringent, and willow bark (source of aspirin) to relieve fever.Priests were invoked only when ordinary remedies fail and no resource left except the aid of spiritual powers.

For ancient Assyrians , seizures were a symptom not of epilepsy but of demonic possession. The connection between the moon and insanity was common in the ancient world. The English Word lunatic comes from Latin fort he moon. Ancient Assyrian cures for driving out the epilepsy demon include hanging “ a Mouse and a shoot of a thornbush” on patient’s door, an exorcist dressed in a red garment and cloak, a raven and a falcon. Although healing practices in ancient Mesopotamia involved the use of magic, chants, and divination, physicians had an extensive knowledge of diagnosis, a wide list of drug treatments, and carried out basic surgery. They were also bound by a well-established, formal code of conduct. Some medical practitioners of the time, known as ashipus, decreed that diseases were caused by spirits and could be cured by sorcery. They would divine which particular evil sprite was responsible for the problem, and then try to drive it away by means of chants, spells, and curses.

Another class of practitioners, the asus, were more involved in practical treatments, such as preparing herbal potions, washing, massage, and bandaging oils onto affected parts of the body. Mesopotamian physicians used around 250 medicinal plants, 120 minerals, and about 200 other substances. Remedies were prescribed for specific diseases: for instance, fish oil and an extract of cedar were thought to treat epilepsy. Doctors were skilled in the treatment of wounds, applying bandages with sesame oil or honey and alcohol to prevent infection. They had a wide knowledge of the external symptoms of diseases, and were able to give accurate descriptions of afflictions, such as epilepsy and tuberculosis. They were also aware that some diseases spread by contagion, and they practiced a form of quarantine to prevent the spread of fevers.

Doctors in Mesopotamia could also perform surgery; a set of bronze needles meant for cataract operations dating from around 2000 BCE has been found. The ruler of Babylon, Hammurabi’s Law Code, written in cuneiform script on a pillar of diorite stone, included several pronouncements on medical care and held physicians responsible both for success and failure. Rewards and punishments depended partly on the social status of the patient. Saving the life of a noble “with a bronze lancet” was worth ten shekels (more than a year’s pay for the average tradesperson), while saving a slave was worth two shekels. However, if a wealthy patient died under the surgeon’s knife, that surgeon could lose a hand—and a lost slave would have to be replaced.

Ancient Mesopotamia often called the cradle of civilization, was home to some of the earliest known human societies, including the Sumerians, Akkadians, Babylonians, and Assyrians. Situated between the Tigris and Euphrates rivers, Mesopotamia was a fertile region that gave rise to advanced agricultural techniques, monumental architecture, and complex social structures. In addition to these achievements, Mesopotamia also played a pivotal role in developing medicine and healthcare, laying the foundation for future medical traditions. The origins of Mesopotamian medicine can be traced back to the dawn of civilization in the fourth millennium BCE, with the emergence of city–states such as Uruk, Ur, and Eridu. In these early urban centers, priests, scribes, and healers played essential roles in maintaining the health and well-being of the community. Medical knowledge was closely intertwined with religious beliefs, with gods and goddesses associated with healing, such as Ninhursag, the Sumerian mother goddess, and Gula, the Babylonian goddess of medicine.

 One of the most important sources of information about Mesopotamian medicine is the “Diagnostic Handbook,” a collection of diagnostic signs and symptoms written in cuneiform script on clay tablets. Dating back to the second millennium BCE, these tablets contain detailed descriptions of various diseases, including fevers, wounds, gastrointestinal disorders, and prognoses and treatments. The Diagnostic Handbook provides insights into Mesopotamian physicians’ diagnostic methods, therapeutic interventions, and medical terminology. Empirical observation, magical incantations, and ritualistic practices characterized Mesopotamian medicine. Physicians, known as “asipu” or “uššipu,” employed a variety of diagnostic techniques, including examining the patient’s pulse, urine, and stool, as well as interpreting omens and dreams. Treatment options ranged from herbal remedies and dietary restrictions to prayers, offerings, and rituals designed to appease the gods and ward off malevolent spirits.

One of ancient Mesopotamia’s most famous medical texts is the “Incantation Series Šurpu,” a collection of magical spells and rituals to cure various diseases and afflictions. Written in Akkadian, the Šurpu incantations invoke the aid of gods, demons, and supernatural forces to banish illness and restore health. These incantations were recited by trained exorcists known as “āšipū,” who specialized in ritual magic and the secret names of gods and demons. In addition to magical incantations, Mesopotamian medicine utilized a wide range of herbal remedies, many of which were derived from local plants and minerals. Clay tablets found in ancient Sumerian and Akkadian cities contain lists of medicinal plants and instructions for their preparation and use.

Plants such as licorice, garlic, and opium were used to treat a variety of ailments, including fevers, coughs, and gastrointestinal disorders. In contrast, minerals such as copper, lead, and sulfur were employed in ointments, poultices, and salves. Surgical interventions were also performed in ancient Mesopotamia, although they were typically reserved for traumatic injuries and emergency cases. Archaeological evidence, such as skeletal remains with signs of surgical procedures, suggests that Mesopotamian physicians were capable of performing amputations, trepanations, and lithotomies. These surgical techniques were performed by skilled practitioners using sharp stone tools and rudimentary instruments made of bronze or copper.

The Mesopotamians believed in the influence of supernatural forces, demons, and evil spirits on health and illness. Disease was often seen as a punishment from the gods or the result of malevolent sorcery, requiring divine intervention or magical remedies to cure. Consequently, Mesopotamian medicine was heavily influenced by religious beliefs and superstitions, with priests and exorcists playing prominent roles in healthcare delivery. In ancient Mesopotamia, medicine was deeply intertwined with spiritual beliefs. Illnesses were often attributed to the actions of gods or evil spirits, and healing practices involved medical treatments and spiritual rituals. The Sumerians, for instance, utilized a combination of herbal remedies and incantations to treat ailments.

The Code of Hammurabi, one of the oldest legal documents, includes regulations on medical practice, indicating a recognition of medicine as a science and an art rooted in spiritual understanding. Similarly, Babylonian texts reveal a sophisticated knowledge of medicinal plants and surgical procedures, that were always performed with spiritual invocations to appease deities or drive away malevolent spirits.  The prevailing belief in the humoral theory, inherited from ancient Mesopotamia , posited that health and illness were governed by the balance of 4 bodily fluids or “humors”–blood, phlegm, black bile, and yellow bile. Imbalances in the humor were thought to cause disease, necessitating treatments such as bloodletting, purging, and emetics to restore equilibrium. (92-93)

A**NCIENT EGYPTIAN MEDICINE**

The ancient Egyptians practiced medicine with highly professional methods. They had advanced knowledge of anatomy and surgery and treated a lot of diseases including dental, gynecological, gastrointestinal, and urinary disorders as well as diagnosed even diabetes and cancer. The used therapeutics extended from different plants to include several animal products and minerals. Some of these plants are still used in the present day. Fortunately, they documented their life details by carving on stone, clay, or papyri.

In Ancient Egypt (3300BCE to 525BCE) , the first dawn of modern medical care has been found, including bone setting, dentistry, simple surgery, and the use of different sets of medicinal pharmacopeias. The first mention of a physician in history is back to 3533BCE, and was documented that Sekhet'enanch, chief physician healed the Pharaoh Sahura of the fifth dynasty from a disease in his nostrils. Documentation of the use of malachite in ancient Egypt as an eye paint and treatment around 4000BCE has been found.

Imhotep (2780BCE),the most famous of early Egyptian physicians, was the chief vizier to the pharaoh Zoser, who was the first king of the Third Dynasty of the Old Kingdom and the engineer of the step pyramid at Sakkara. Pictures carved on the door-posts of a tomb in Memphis are the earliest known pictures of surgical operations (2500B. C.)

Ancient Egyptians considered that health and illness resulted from a person’s relationship with the universe including people, animals, good and bad spirits .The basic concept of health and disease according to the Ebers Papyrus is that the body has twenty-two *mtw* (vessels) which connect the body carrying various substances such as blood, air, semen, mucus, and tears. These *mtw* (vessels) are linked up at some junctures, controlled by the heart, and opened to the outside from several points like an anus. Egyptian healers should determine the condition of *mtw*-vessels by examination of the patient’s pulse. The balance (*maat*) of this movement is vital for human health just like the balance of the Nile flooding and irrigating is vital for Egypt. If the *mtw*-vessels were blocked by foreign or noxious matters (*wekhedu*), the disease takes place. These matters may enter the patient’s body through wounds or natural openings.

Medical practice was rigidly prescribed by the Hermetic Books of Thoth, and if a patient died as a result of a deviation from this strict line of treatment, it was regarded as a capital crime, if the patient didn’t improve after four days of treatment, physicians were allowed to modify the treatment . There was a hierarchy of medical profession starting with the 'swnw' (ordinary doctor); 'imyr swnw' (overseer of doctors); 'wr swnw' (chief of doctors); 'smsw swnw' (eldest of doctors); and 'shd swnw' (inspector of doctors), there is also evidence proved the existence of women physicians. Ancient Egyptians got a surprising knowledge about anatomy, a lot of diseases of the osseous, alimentary, respiratory, circulatory, genital, muscular, nervous, ocular, auditory, and olfactory systems were described in details, They identified the function of the heart, and its relation to the two types of blood vessels, in addition, cerebrospinal fluid was known to them too. They thought that the heart was the center for all body fluids including urine and tears).

The surgery in ancient Egyptian was so advanced, surgeons used various instruments such as the scalpel, forceps, and scissors, splints made of reeds tied together by strips of linen or pieces of wood padded with plant fibers. They sutured wounds, stopped bleeding using cautery. Boils, abscesses, and septic wounds were opened surgically and drained by pieces of linen, and poultices were used as well. A dislocated shoulder and mandible were treated and reduced by the method used today. The plaster used for fractures consisted of linen soaked in a sticky material which hardened. They made circumcision and the surgical treatment of a hernia.They knew psychology. The patient was asked to write his troubles in a letter to dead relatives (catharsis), to be interpreted. Doctors used to prescribe even a remedy of different drugs, instead of a single drug.

The routes of drug administration were basically five; oral, rectal, vaginal, topical, and fumigation. Treatments were given in different forms like; pills, cakes, ointments, eye drops, gargles, suppositories, fumigations, and baths. The translation of the Rosetta stone in 1822, gave an excellent chance to translate several ancient Egyptian papyri including medical papyri. The hieratic language was used for writing on papyri from right side to left, using red ink for the headings and black ink for the bulk. Papyrus made from *Cyperus papyrus* by split interweaving, pounding in water, and drying to form brownish sheets then being written with brush and ink, and finally glued at edges, making a roll.

The ancient Egyptian medical papyri documented several details about the way by which they practiced medicine. The papyri described in-depth the diseases, how to diagnose, and different remedies that were used to treat including herbal remedies, surgery, and even magical spells. Starting from the Middle Kingdom, about 1800 to 300BCE, the remains of more than 40 papyri describing the medical procedures that used to treat various illnesses have explored.Most knowledge of ancient Egyptian traditional medicine was originated from the ancient Egyptian medical papyri includes Ebers papyrus, Edwin Smith papyrus, Kahun Papyrus, Ramesseum medical papyri, Hearst papyrus, London Medical Papyrus, Brugsch Papyrus, Carlsberg papyrus, Chester Beatty Medical Papyrus, Brooklyn Papyrus, Erman Papyrus, and Leiden Papyrus.

All of the treatments in the Kahun Papyrus are non-surgical, including fumigation, massage, and medicines introduced into the body in the form of pessaries or as a liquid to be drunk or rubbed on the skin. Eyes and the womb are, closely linked in ancient Egyptian health and medicine. The papyrus discusses each case as the following; a brief description of the symptoms, then the physician is advised how to tell the patient her diagnosis and, finally, treatment is suggested. In order to prevent pregnancy (conception), the papyrus recommends excrement of crocodile dispersed in honey or sour milk with a pinch of natron (sodium carbonate decahydrate) and injected into the vagina.

Another papyrus, named as Ebers, the man who purchased it in 1862 from a dealer, was a very old medical text dating back to 1600BCE, using 328 different ingredients (most of them are derived from plant species) to make 876 prescriptions and surgical trauma discussing 62 diseases and surgery cases, just fourteen cases with known treatments, other cases as chronic diseases difficult to treat or even unknown. It has seventeen pages documenting head, neck, and arms injuries in addition to detailing a diagnosis, prognosis, and cause of the trauma. The treatments included the closure of wounds using sutures, prevent and treat infection with honey and stop bleeding using raw meat. The papyrus recommends immobilizing the head and neck in the case of its injuries in addition to some detailed anatomical observations. Six cases of spinal injuries were documented in the papyrus, diagnosed with a specific description of symptoms in addition to the clear description for the treatment of three cases of them.

The most complete surviving and longest medical papyrus (68 feet in length and 12 in. in width) , being an encyclopedia of medicine discussing details of a huge number of prescriptions and treatments for a wide variety of diseases were in vogue among Egyptians of the eighteenth dynasty (c. 1630–1350BCE) including helminthiasis, ophthalmology, dermatology, gynecology, obstetrics, dentistry, and surgery. There is a short section on psychiatry, describing a “despondency” similar to depression , with more than 700 magical formulas were described . Ebers papyrus, which lists hundreds of magical chants and spells against bad spirits, as well as mineral and herbal remedies. It describes a range of ailments too, including parasitic diseases, bowel disease, ulcers, urinary difficulties, female disorders, skin rashes, and eye and ear problems.

One of ancient Egypt most famous medical documents is the Edwin Smith Surgical Papyrus, dating back to around 1600 BCE. named after the American archaeologist who purchased it in the 19th century, the Edwin Smith Papyrus, one of the oldest known medical texts, covers gynecology, dermatology, ophthalmology, and dentistry, reflecting ancient Egyptian physicians’ diverse interests and expertise providing valuable insights into Egyptian comprehensive medical knowledge and practices compendium encompassing over 700 magical formulas, prescriptions, and remedies for various diseases and conditions , anatomical observations, and diagnostic methods, containing detailed descriptions of surgical techniques , such as suturing, bandaging, and cauterization to treat various injuries and ailments including fractures, wounds, and tumors. The Edwin Smith papyrus is much more systematic and explanatory— closer in approach to a modern medical text. It covers a total of 48 typical “case histories.”

The cases generally start at the head and work down the body, and each progress in a logical manner, with a title and notes on examination, diagnosis, prognosis (prediction), and treatment.The Edwin Smith Papyrus and the Ebers Papyrus, among the oldest medical documents, provide insights into Egyptian medical practices that combined practical treatments with spiritual rituals. Egyptian physicians, known as “swnw,” were often priests who performed healing as part of their religious duties. They utilized a vast pharmacopeia derived from plants, minerals, and animal products, but prayers and incantations typically accompanied these treatments to invoke divine healing powers. In ancient Egypt, healing was deeply intertwined with religion and magic, with priests serving as healers and medical practitioners.

The Hearst Papyrus, was thought to be a reference for a local physician, and, less carefully organized than Ebers and contains six remedies related to purging, eight remedies relating to teeth and bones, seven remedies relating to pains, eleven remedies relating to digestion, ten remedies relating to the urinary organs, seven remedies related to head diseases, thirty remedies relating to the vessels, eight remedies relating to the blood, thirteen remedies relating to the hair, the skin, thirty-six remedies relating to fingers and toes, eighteen remedies relating to broken bones, seven or more remedies concerning bites in addition to two incantations and twelve remedies against unidentified diseases.

The Berlin papyrus was discovered in a jar during excavations at Saqqara in the early twentieth century. It consists of 279 lines of prescriptions and is housed in the Berlin Museum. The Berlin Papyrus discusses a pregnancy test; the woman has to moisten barley and emmer with her urine every day. If the barley grows, she will get a boy child. If the emmer grows, she will get a girl child. If neither grows, she will not get a birth. There is a lot of prescriptions for the management of different urinary disorders such as; hematuria, urine retention, urine frequency, infection, and dropsy have been mentioned in medical papyri . The ancient Egyptian physicians were aware of a variety of cardiac diseases, including arrhythmia, aneurysm, congestive heart failure, and venous insufficiency.

Ancient Egyptians treated different dental problems including dental caries, mouth ulcers, teeth extraction, pyorrhea, abscesses, calculus formation, gums inflammation, jawbone, and jaw dislocation, were found in the Edwin Smith and Ebers Papyri . They performed dental surgeries, where surgically produced holes used to an abscess drain under the 1st molar were found in the mandible of a 4th dynasty mummy around (2625–2510BCE) .A mummy had two teeth, a lower third and a lower second molar joined together by a golden wire piece woven around the gingival margins.

The first known medical reference to diabetes mellitus was the Ebers Papyrus containing the following description; “. *to eliminate urine which is too plentiful*.” the condition described was polyuria (increased Urine volume) which refers mainly to diabetes . The first written description of cancer was reported in the Edwin Smith Papyrus, for a breast cancer case and described as “*bulging tumor of the breast was a grave disease and there was no treatment for it*” . In the Ebers Papyrus, several tumors have been described such as; enlarged thyroids, polyps, and tumors of the pharynx, skin, stomach, rectum, and uterus . Some reports indicated the usage of different types of treatments for cancer such as cautery, knife, or salts of lead and sulfur or arsenic paste.

Humans relied on nature as the main source of treatments using different sources such as plants , marines , and microbes. The ancient Egyptian pharmacopeia comprised a wide diversity of treatments, including minerals, metals, animals, and plant sources. Ancient Egyptians used the whole plant, or its fruit, leaves, juice, or root belonging to different species such as acacia, anise, barley, cassia, castor bean, coriander, cucumber, cumin, date, fennel, fig, mulberry, garlic, gourd, juniper, leek, lettuce, lotus, peas, poppy seeds, saffron, sunflower, styrax, terebinth, wheat, willow buds, white thistle, and wormwood. Plants contain wide range of bioactive secondary compounds that belong to vast diverse of chemical classes such as saponins , diterpenes , sesquiterpenes , pyrones , isochromenes , flavonoids , isoflavonoids , and alkaloids .

Minerals and metals in the Egyptian pharmacopeia included antimony, alum, carbon from charred wood, copper, feldspar, iron oxide, limestone, red ochre, sodium carbonate, sodium bicarbonate, salt, stibnite, sulphur, and arsenical compounds that were recommended for local mild astringent or antiseptic action in cases of boils, felons, and burns. Antimony sulphide given by mouth for bilharziasis, Sulphur for scabies, calamine for its soothing effect, yellow ochre hydrated oxide of iron, used in the anemia of ankylostoma, red ochre natural oxide of iron, to combat hemorrhage, green copper ore against eye inflammation. Some minerals used because of their color:   
silvery bluish White color ofantimony for cosmetic use, lead sulfides to produce the black paints of lead sulfides for beautifying men's and women's eyes, the green color produced by malachite in eye make-up , blue-green of chrysocolla and copper silicate for ornamental stones.

Kahun papyrus mentioned that natron used as a household cleansing product can also be used also for contraception, namely: *“honey, sprinkle over her womb, this to be done on a natron bed”*. Nubian ochre was used in an antidiabetic remedy and to fix a loose tooth. Many different types of drugs from animal sources are recommended in the medical papyri. Fat and grease from different animals are mentioned in various prescriptions, for internal use or topically as a treatment or as a base in the formation of ointments. Goose-fat was a part of a remedy used orally to remove pain and is also used externally for relaxation.

Different forms of animal-derived drugs such as; urine, eggs, feces, or milk in addition to animal structural components such as blood, bone, meat, bone marrow, bile, liver, spleen, and skin were used. The liver (which is rich in vitamin A) was described to prevent grey hair and to treat night blindness. Animal constituents were obtained from a wide range of animals, including cow, goose, donkey, man, cat, pig, mouse, goat, sheep, bat, hippopotamus, antelope, dog, insect, ostrich, pigeon, pelican, raven, frog, lizard, snake, tortoise and crocodile, invertebrates (beetles and worms) and fish. Because of its strong curative propertie , bee’s wax was recommended for use as a vehicle or binding material in various ointments or preparations for applications to the skin or wounds. Honey was a vital constituent in about five hundred prescriptions and remedies used for its efficacy, also as a vehicle. Honey was the most commonly used agent in the Hearst document as anti-cough, antidiarrheal, wound healing, antiseptic, fixator of a loose tooth, and toothache reliever. Other foodstuffs such as; beer, wine, milk, and water were also used as vehicles.

Prescriptions for cosmetic use have been mentioned also in several Egyptian papyri, for instance, these sentences were written in the Ebers papyrus “*To make the skin of the face smooth, soak meal in spring water. Let her wash her face daily, and then apply the meal*“ . Some prescriptions have been mentioned for households such as cleaning the house and keep harmful animals and rodents away “*To keep away mice, smear everything possible with cat's fat.”* “ *To prevent the hefu-snake from coming out of his hole, put a dried ant-fish, or soda, or an onion upon it—he will not crawl out*.” A lot of ingredients that used in ancient Egyptian remedies are still used for the same purpose today. Their biological activities were confirmed using modern methods and techniques. For example, *Ammi majus* fruit which is endogenous to Egypt was used to treat vitiligo. A compound (8-methoxypsoralen) has been isolated from *Ammi majus*  to treat psoriasis and vitiligo .

*Ziziphus spina* has been mentioned as an ingredient of 33 ancient Egyptian prescriptions under the name nebes, to treat different types of inflammations. Gallocatechin and epigallocatechin were identified as two major compounds in the plant, and found significantly correlated to the expression of 79 inflammation-related genes in the National Cancer Institute (NCI, USA) cell lines . The methods of analysis of the materials (organic and inorganic) that incorporated in ancient Egyptian pharmaceuticals and cosmetics preparations including (lead chloride, cerussite, beeswax, mastic resin, pine resin, frankincense resin, castor oil, animal fat, and starches) and the powerful effect of honey as an antimicrobial agent besides its great effect in wound healing with six different mechanisms of action have been reported.

Ancient Egyptians had a great knowledge of different medical fields such as anatomy, surgery, and general medicine; so they could diagnose and treat several diseases successfully. Hundreds of cases have been mentioned in several medical papyri. The treatment in that time included a huge diversity of sources as plants, animals, and minerals. The Ebers Papyrus tells us of three types of medical professionals: the doctor (swnw), who is a secular physician; a priest (wab), who is a healer; and a magician (sau). Egyptians believed that disease or pain was the effect of hostile divinities or demons, and that a cure could be achieved by magical or religious incantations. As effective remedies were found, a more rational approach developed. The oldest mummy of a priest and “chief physician of the secret of the palace,who lived during the 5th Dynasty, was discovered .

When Herodotus visited Egypt in 450 BC, he noted that Egyptian medicine was that of specialists, in “diseases of the eyes, others of the head, others of the teeth, others of the stomach, and so on….”The chief of dentists, Khuy, combined dentistry (ibhy) and proctology, “guardian of the anus” (neru pehut). There are records of as many as 150 swnw in pharaonic Egypt, and records of how physicians were paid through a barter system regulated by the state. Salary was rations of cereal, bread, and beer, the ingredients of a basic diet. Most physicians were in the middle class, along with priests, scribes, and skilled workers, with some attached to the royal palace being elevated to the upper class.

Civilization in Ancient Egypt was not only the pyramids and tombs, but it involved all aspects of human life. Health and wellbeing was one of the most cared arts by the pharaohs. Both the physicians and magicians participated in the field of medical care. From holistic view they conceived health and sickness as an unceasing fight between good and evil. Most of the complementary medicine modalities were originated from ancient Egyptians. They conceived a system of up to 46 channels in the body, emanating from the heart. They viewed the arteries, veins, and intestines—and, tendons and nerves—as channels of the body. They believed that “flow” through the channels was important for good health, and that the body’s channels could become blocked by evil spirits, which would cause sickness.

Their remedy was to unblock these canals by using various purges, laxatives, and emetics, and offering prayers and gifts to relevant gods to remove the root cause. The Channel Theory was an important turning point in medicine. Although it had a metaphysical basis, it was among the first attempts to link illness with the body’s processes, and it resulted in the development of treatments that focused on the body rather than simply pacifying the spirits. Ancient Egyptian medicine occupies a unique place in the annals of medical history, characterized by a rich tapestry of empirical knowledge, magical incantations, and religious rituals, as well as exemplified the integration of spiritual and rational approaches. Spanning over 3 millennia, from the predynastic period to the Roman conquest, Egyptian medicine has evolved from primitive folk remedies to sophisticated medical practices that laid the foundation for future medical traditions.

The origins of Egyptian medicine can be traced back to the dawn of civilization along the banks of the Nile River, where early inhabitants developed rudimentary healing techniques to address injuries, illnesses, and childbirth. Archaeological evidence, such as the mummified remains of individuals with signs of surgical interventions, suggests that Egyptians possessed basic knowledge of anatomy and surgical procedures as early as 3000 BCE. Mmedical knowledge during this period was largely shrouded in mysticism and superstition, with an illness often attributed to supernatural causes such as curses, malevolent spirits, or divine wrath. The earliest known medical texts, dating back to around 2600 BCE, were found inscribed on the walls of the Pyramid of Unas in Saqqara. Known as the Pyramid Texts, these hieroglyphic inscriptions contain spells, prayers, and incantations to protect the deceased pharaoh and ensure his journey to the afterlife. Among hundreds of spells recorded in the Pyramid Texts are several about healing and treating diseases, reflecting the intertwined nature of magic and medicine in ancient Egyptian culture.

In addition to surgical procedures and pharmacological treatments, ancient Egyptian medicine also utilized a variety of noninvasive therapies, such as massage, hydrotherapy, and dietary interventions. Massage, known as “drd,” alleviated muscle pain, improved circulation, and promoted relaxation. Hydrotherapy, in the form of baths and fumigations, was believed to cleanse the body of impurities and restore vitality. Dietary interventions, including herbal teas, poultices, and enemas, were prescribed to treat digestive disorders, fevers, and parasitic infections.

Central to Egyptian medicine was the concept of ma’at, the cosmic order, and harmony that governed the universe and all aspects of life. Illness was seen as a disruption of ma’at, requiring the intervention of physicians, priests, and deities to restore balance and order. Healing rituals and medical treatments often incorporated religious symbols, prayers, and offerings to invoke the aid of gods and goddesses associated with healing, such as Sekhmet, the lion-headed goddess of medicine, or Imhotep, the deified physician and architect of the Step Pyramid of Djoser.

Ancient Egyptians did not have a clear dichotomy between both medicine and magic, and considered health and illness resulted from a person’s relationship with the universe including people, animals, good and bad spirits .Ancient Egyptian medicine, focusing on practical treatments and spiritual rituals, continues to influence modern interpretations of health and healing. The Egyptians believed in ma’at, or cosmic order, and viewed illness as disrupting this balance. Healing practices included surgical procedures, herbal remedies, and incantations to restore bodily harmony with the divine. Today, these principles are echoed in holistic approaches to health that emphasize the importance of alignment with nature and the cosmos. The legacy of ancient Egyptian medicine can be seen in the growing interest in natural remedies, herbal medicine, and alternative therapies. (94-95).

**HIPPOCRATIC MEDICINE**

Asclepius and Hippocrates focused medical practice on the natural approach and treatment of diseases, highlighting the importance of understanding the patient’s health, independence of mind, and the need for harmony between the individual, social and natural environment, as reflected in the Hippocratic Oath. According to the literature, “healthy mind in a healthy body” was the main component of the Hippocratic philosophy. Three main categories were observed in the Hippocratic provision of care: health promotion, interventions on trauma care, and mental care and art therapy interventions. Health promotion included physical activity as an essential part of physical and mental health, and emphasized the importance of nutrition to improve performance in the Olympic Games. Interventions on trauma care included surgical practices developed by Hippocrates, mainly due to the frequent wars in ancient Greece. Mental care and art therapy interventions were in accordance with the first classification of mental disorders, which was proposed by Hippocrates. In this category music and drama were used as management tools in the treatment of illness and in the improvement of human behavior.

The role of Asclepieion of Kos indicates a holistic health care model in care provision.Mental and physical health are interrelated and the body and mind should be in harmony. Aristotle believed that sports and gymnastics were essential to the development of the human body to optimize functional capacity and harmony between mind and body, hence the famous phrase “healthy mind in a healthy body”.Physical activity was a necessary part of the training done in schools primarily to promote physical and mental health [https://pmc.ncbi.nlm.nih.gov/articles/PMC4263393/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4263393/#b15-jmehm-7-6) . Health promotion appeared during the Olympic Games since the care of athletes and prevention of injuries were specialist services provided by instructors called “paidotrivai”. According to Hippocrates’s study “on food”, for the exercises that were done by athletes, olive oil was used to increase body temperature, warm up and for muscles to be flexible so as to avoid sport injuries. Figs and other fruits with high glucose concentration that provide energy were offered to athletes to improve performance

There are records that indicate treatment practices on wounds during the Trojan War and even treatment of infected wounds. For such treatments medicinal preparations were taken from nature, such as seawater, honey, vinegar, rainwater and medicinal plants in the form of powder. In Homer’s “Iliada” injuries and amputations that reflect the actual care of wounds are described in wars in ancient Greece, and Hippocrates noticed the separation of limb gangrene and made incisions between dead and alive tissue to treat the condition . Hippocrates’s views were highly innovative for their time as he suggested chest tube output for possible liquid in external fixation and traction when aligning broken bones. He believed that in order to properly and quickly heal the wounds they must be kept dry, after being taken care of using pure water or wine.

In addition, the formation of pus was considered a positive factor for the reduction of wound complications because of the frequent occurrence of infections. As a consequence, the combined findings of Hippocrates and Galen had an influence on surgical care practices of injuries and wounds until the Middle Ages The first classification of mental disorders proposed by Hippocrates was: Mania, Melancholy, Phrenitis, Insanity, Disobedience, Paranoia, Panic, Epilepsy and Hysteria. Psychological and mental illnesses were viewed as the effect of nature on man and were treated like other diseases. Hippocrates argued that the brain is the organ responsible for mental illnesses and that intelligence and sensitivity reach the brain through the mouth by breathing and believed that mental illnesses can be treated more effectively if they are handled in a similar manner to physical medical conditions.

According to Hippocrates, the diagnosis and treatment of mental and physical diseases is based on observation, consideration of the causes, balance of theory and on the four liquids, blood, phlegm, yellow bile and black bile.The role of music and theater in the treatment of physical and mental illnesses and the improvement of human behavior was essential. It was believed that healing the soul through music also healed the body, and there were specific musical applications for certain diseases. For instance, the alternating sound of the flute and harp served as a treatment for gout. Asclepius was the first to apply music as therapy to conquer “passion” .

Aristotle claims that the effect of religious melodies that thrill the soul resembles those who have undergone medical treatment and mental catharsis. The ancient tragedies acted as psychotherapy for patients. The Theater of Epidaurus at the Ancient Temple of Epidaurus was the place where “catharsis” or the release of emotions through performance took place. “quiet rooms” were designed in which patients would go to sleep so that they could dream of being mentally healthy, and it was believed that this would help them to improve their mental health.

The concept of “physis” was first proposed by Hippocrates, who changed hieratic or theocratic medicine into a rational discipline in a holistic health care model, and in his school science met with drug therapy, diets, and physical and mental exercise, as well as divine solicitation. The Asclepieion of Kos offered all patients general treatment that included physical exercise, massage and walks considered necessary to restore health, well-being of the soul and the inner peace , and using dreams both for diagnostic and for therapeutic reasons. To achieve the desired therapeutic result, the therapist should have prior understanding of the concept of soul and its distinction from the body according to the Platonic trisection of the soul.

Another great contribution of Hippocrates to medicine is the professional ethics and standards that are respected and observed even today. Hippocratic medicine is founded on the available evidence based knowledge, as Hippocratic physicians were required to give complete and detailed medical histories, specifically, in their diagnoses of syndromes or diseases, to note the geographical location, climate, age, gender, habits and diet as well as rational mood swings, sleep duration, dreams, appetite, thirst, nausea, location and severity of pain, chills, coughing, sneezing, belching, flatulence, convulsions, nosebleeds, even menstrual changes were recorded. The physical examination required great attention to be given to fever, respiration, paralysis and color of the limbs, pain on palpation, stool, urine, sputum and vomit. The overall assessment of these recordings interpreted the final diagnosis and determined the type of treatment of the disease. The key area of Hippocratic medicine was the precision or the details of prognosis and the reliability of prognostic signs. The Hippocratic physician had to examine a patient, observe symptoms carefully, make a diagnosis and then treat the patient [https://pmc.ncbi.nlm.nih.gov/articles/PMC4263393/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4263393/#b33-jmehm-7-6) .

Hippocrates established the basics of clinical medicine as it is practiced today. He introduced numerous medical terms universally used by physicians, including symptom, diagnosis, therapy, trauma and sepsis and described a great number of diseases without superstition. Their names are still used in modern medicine, for instance diabetes, gastritis, enteritis, arthritis, cancer, eclampsia, coma, paralysis, mania, panic, hysteria, epilepsy and many others. Hippocrates greatly contributed to modern medicine by declaring that medicine should depend on detailed observation, reason and experience in order to establish diagnosis, prognosis and treatment. After Hippocrates there was no longer a mixture of superstition, magic, religious views and empirical treatments examined by priest-physicians, and medicine became a real science through accumulating experience [https://pmc.ncbi.nlm.nih.gov/articles/PMC4263393/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4263393/#b34-jmehm-7-6) . “healthy mind in a healthy body” was the key for the physical and mental health of humans, and health care provision should primarily offered promoting both; health care and psychological support aimed to approach the psychosomatic entity and not only the symptoms of diseases. Mental and physical cares were provided parallel to one another, regardless of whether the disease came from the soul or the body. Hippocrates set the stepping stones for the foundations of medicine, developing medical terms and definitions, protocols and guidelines for the classification of diseases, which are considered the gold standards for the diagnosis, management and prevention of diseases.

From the spiritual belief that physical health and spiritual purity are interconnected to rational approaches began with the works of Hippocrates of Kos island in aegean sea, referred to as the “Father of Medicine.” and emphasized empirical observation and logical reasoning, laying the groundwork for modern scientific methods. Hippocratic Era, spanning roughly from the 5th century BCE to the 3rd century BCE, marks a pivotal moment in the history of medicine and the emergence of rational thought in healthcare and witnessed significant advancements in medical theory, practice, and ethics that laid the foundation for modern Western medicine. .

The Hippocratic Corpus, a collection of over 60 medical texts attributed to Hippocrates and his followers, is the primary source of information about medicine during this era and includes texts that reflect a holistic view of health, considering the balance of bodily humor and the influence of environmental and lifestyle factors on health. While the authorship of these texts is debated, they represent a remarkable synthesis of empirical observation, clinical experience, and ethical principles that have shaped medical thought for centuries.  Central to the Hippocratic approach to medicine was the concept of “physis,” or nature, as the guiding principle of health and disease.

According to Hippocratic teachings, the body possesses an inherent capacity for self-healing, and illness arises from imbalances or disturbances in the body’s natural equilibrium. This synthesis of empirical and holistic thinking paved the way for a more systematic and rational approach to medicine while acknowledging the importance of the patient’s overall well-being.Physicians were advised to work harmoniously with nature, supporting the body’s innate healing processes rather than imposing aggressive interventions. Observation and clinical experience played a crucial role in Hippocratic medicine, with physicians encouraged to closely observe their patients, record their symptoms, and monitor disease progression over time.

The Hippocratic physician was expected to be a keen observer, skilled diagnostician, and compassionate caregiver, capable of interpreting subtle signs and symptoms to formulate accurate diagnoses and prognoses. The Hippocratic Corpus contains detailed descriptions of various diseases, injuries, and surgical procedures, reflecting ancient physicians’ diverse medical knowledge and expertise. Topics covered include anatomy, physiology, pathology, pharmacology, obstetrics, pediatrics, surgery, and ethics, providing a comprehensive overview of medical practice during this era.

One of the most famous works in the Hippocratic Corpus is the “Hippocratic Oath,” a solemn pledge physicians take to uphold ethical standards and moral principles in medicine. The Oath emphasizes the duties of physicians to their patients, including confidentiality, beneficence, non-maleficence, and professional integrity. It continues to serve as a guiding ethical framework for medical professionals today.Surgery considered a last resort, was performed by specialized practitioners known as “chirurgeons” or “hand-workers.” during the Hippocratic Era. Surgical procedures described in the Hippocratic Corpus include wound care, fracture management, tumor excision, and lithotomy (removing bladder stones). Surgical instruments such as scalpels, forceps, and probes were used, and techniques such as cautery and ligature were employed to control bleeding.

Pharmacology was another essential aspect of Hippocratic medicine, with physicians using a variety of herbal remedies, dietary interventions, and mineral preparations to treat a wide range of ailments. Herbal medicines were prepared from plants such as opium poppy, mandrake, and henbane, while dietary recommendations emphasized the importance of moderation, balance, and variety in food choices. The Hippocratic physician was also expected to provide holistic care for their patients, addressing the physical symptoms of disease and the psychological, social, and spiritual dimensions of health and well-being.

The “Hygieia,” or holistic health, encompassed physical fitness, mental resilience, emotional balance, and social harmony, emphasizing the interconnectedness of body, mind, and spirit.  The Hippocratic physicians lacked knowledge of germ theory, microbiology, and the role of infectious agents in disease, leading to erroneous beliefs about the causes and transmission of illness. Treatment options were often limited to empirical remedies, dietary restrictions, and supportive care, with little understanding of the underlying mechanisms of disease. (96)

**AMERICAN INDİGENOUS PEOPLES' MEDİCİNE**

**Indigenous Peoples' Medicine in Canada**

Indigenous peoples in Canada have been using plants and other natural materials as medicine. Plant medicines are used more frequently than those derived from animals. Indigenous peoples have identified over 400 different species of plants (as well as lichens, fungi and algae) with medicinal applications. Medicine traditions — the plants used, the ailments treated, protocols for harvesting and application, and modes of preparation — are similar for Indigenous peoples across the country. In many Indigenous communities, there are recognized specialists trained in traditional medicine, and their practice reflects spiritual aspects of healing as well as physical outcomes. The therapeutic properties of Indigenous medicines are attributable to particular compounds and their effects on the body, Within Indigenous communities, specific methods of harvesting and preparation of medicines are considered intellectual property of particular individuals or families.

The use of medicinal plants has been a part of people’s healing traditions worldwide, probably from humans’ earliest beginnings. Among Indigenous peoples in Canada, the origin of some medicinal applications is chronicled in stories, such as in the [Siksika (Blackfoot)](https://www.thecanadianencyclopedia.ca/en/article/blackfoot-siksika) narrative of how a woman named Last Calf, who had tuberculosis, gave food to a beaver, who in turn gifted her with a vision of a cure for her ailment. She was told to boil the pitch of the lodgepole [pine](https://www.thecanadianencyclopedia.ca/en/article/pine) (*Pinus contorta*)in water and drink the infusion, while singing a special song.

After following these instructions, Last Calf was cured.All different parts of plants — roots and underground parts, bark, leaves, buds, flowers, fruits, and sap or pitch — have had recognized medicinal uses, and there are many different modes of preparing and applying them. Medicinal plants contain a range of diverse organic compounds, including alkaloids, glycosides, tannins, flavonoids, resins and volatile, or essential oils. The quantities of these compounds vary with the lifecycle stage, plant part, location, and genetic makeup of the plant, as well as what the weather was like and which plants are growing nearby. The specific compounds may interact in different ways to produce therapeutic effects.

Medicinal plants are treated with great reverence and respect, in acknowledgement of their gifts and service to people. Healers carefully prepare themselves for their work, and follow strict cultural protocols relating to harvesting, preparing and administering their medicines. Although some types of healing require particular spiritual preparation, traditionally healers and shamans in Canada have not relied on mind-altering plants or mushrooms to the same extent as in parts of central and South America. Healers do undergo particular purification rituals to give them special energy that often involve fasting and taking certain preparations of plants as emetics or purgatives to give them the powers required to do their work. There is no strict division between physical and spiritual aspects of healing. (97)

**NATIVE AMERICANS’MEDICINE**

Many of [Native Americans](https://share.america.gov/21st-century-native-americans-tell-their-stories/)‘ innovations in health and medicine have been around for thousands of years, predating — and contributing to — Western medicine. Native Americans chewed willow bark to soothe aches and pains. The active ingredient in the bark is salicin, a chemical that in 1897 formed the basis of the discovery of aspirin, the most commonly used drug in the world. Salicin is the precursor of salicylic acid, the active ingredient in many over-the-counter acne treatments and dandruff-fighting shampoos.The world can thank Native Americans — the Iroquois and Seneca tribes, in particular — for inventing baby bottles and baby formula, important to infants’ health when breast milk is not available. Native Americans invented syringes. The White Mountain Apache Tribe showed oral rehydration treatments prevented diarrhea-related deaths in children. The landmark research and subsequent studies led to the creation of Pedialyte, a popular treatment for diarrhea.

“Native Americans have been using traditional healing practices, or ways of healing, for centuries,” Native American (NA) traditional healing is identified by the National Institutes of Health/National Center for Complementary and Alternative Medicine (NCCAM) as a whole medical system that encompasses a range of holistic treatments used by indigenous healers for a multitude of acute and chronic conditions or to promote health and wellbeing.[https://pmc.ncbi.nlm.nih.gov/articles/PMC2913884/](https://pmc.ncbi.nlm.nih.gov/articles/PMC2913884/#R2)  While there are individual tribal differences (i.e., the use of specific healing practices), there are also shared health beliefs and interventional strategies, including a health promotion foundation that embraces bio-psycho-socio-spiritual approaches and traditions. Native Americans in Arizona run each day to greet the dawn, a practice that not only conditions their bodies but also nourishes their spiritual wellbeing. Stories and legends are used to teach positive behaviors as well as the consequences of failing to observe the laws of nature. Herbs, manipulative therapies, ceremonies, and prayer are used in various combinations to prevent and treat illness. For thousands of years, traditional indigenous medicine have been used to promote health and wellbeing for millions of Native people . Native diets, ceremonies that greet the seasons and the harvests, and the use of native plants for healing purposes have been used to live to promote health by living in harmony with the earth.

Ceremonies play an important role in the overall wellbeing of traditional Native American people (NA) whose ceremonies involve the patient, the family, and the community in the healing process. Ceremonial gatherings may last for days or weeks; the more people that are present, the greater the healing energy. Through their participation in songs, prayer, music, and dance, the family and community contribute healing energy to the patient.People of all cultures utilize symbolism found in their various religions and spiritual practices to cope with health problems. NA healing ceremonies rely on the traditional symbols as ritualistic objects. The symbols cue bio-psycho-social-spiritual healing responses by restoring the harmony necessary for health. Symbolism, associated with ceremonies , can be incorporated into their treatment plan to create a powerful healing synergy. Spiritual treatments are thus an integral part of health promotion and healing in Native American culture. The inclusion of family and community in treatment plans, decreases the isolation and, thinking about the lack of person-environment harmony and balance may important clues for the diagnostic process. In Native American culture there is a saying that “we are all related”; all things live in relationship to one another. Living in harmony with the earth and the environs has meaning and purpose, the earth, and its peoples.

The majority of the Native Americans descended entirely from a single group of migrants that crossed over the Bering land bridge between Asia and America that existed more than 15,000 years ago. The origins of Native American healing practice and ceremony are as diverse and rich as the tribes themselves. The healing practices varied widely from tribe to tribe, involving various rituals, ceremonies, and a diverse wealth of healing knowledge. At the heart, the tribes’ medicine man was the spiritual guide of the tribe and its leader in an emergency.

Most tribes believed that health was an expression of the spirit and a continual process of staying strong spiritually, mentally, and physically. Each person was responsible for their own health, and all thoughts and actions had consequences, including illness, disability, bad luck, or trauma.  There had to be balance and harmony between themselves, those around them and their natural environment. Herbal remedies filled an essential role within the healing practices, stretching beyond the body’s aches and pains and into the realm of spirituality and harmony.

Indigenous Peoples in North America have a long history of using plants to treat ailments. Numerous plants, such as black cohosh, echinacea, sarsaparilla, goldenseal, skullcap, witch hazel, mugwort, yarrow, sweetgrass, sage, cranberry, saw palmetto, ginseng and garlic. Black cohosh contains estrogen-like compounds that can relieve hot flashes, sweetgrass has the blood thinner coumarin, and ginsenosides in ginseng may help with some digestive problems.Native American healing practices  involved the use of sacred plants, such as sage and sweetgrass, in cleansing ceremonies **(98)**

**Medicine among the ancient Maya**

Medicine among the ancient Mayas was a blend of religion and science. It was practiced by priests who inherited their position and received extensive education. The Mayas sutured wounds with human hair, reduced fractures, and used casts. They were skillful dental surgeons and made prostheses from jade and turquoise and filled teeth with iron pyrite.

A total of 155 plants used for ethnopsychiatric conditions related to anxiety, depression, memory loss, epilepsy, and insomnia, were found to be used  in Mesoamerica by Mayan groups.

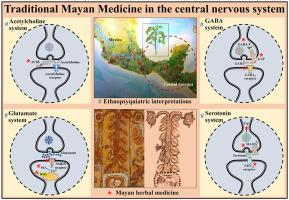


Fig15. Traditional Mayan Medicine.

The concept for explanation of ethnopsychiatric conditions was that a traumatic experience from a frightening event can produce a belief of being seized by a supernatural entity and involves the loss or imprisonment of a part of the soul or spirit accompanied various general symptoms such as restlessness during sleep, loss of appetite, irritability, inability to urinate, weakness, depression, introversion, fever, muscular pain, nausea, vomiting, diarrhea, and vertigo.Some ritual plants are essential for the healer's work, especially for ritual cleansing. Insomnia and stress are traditionally treated with herbal remedies. Epilepsy was traditionally thought to be caused by witchcraft and treated by a spiritual healer including treatment with plants used for spiritual protection and cleansing. An example of anxiety-related condition was nervios, a concept widespread in Latin America associated with insomnia, nervous tension, and psychological stress. Depression, associated with feelings of sadness, is believed to be produced by witchcraft and several herbs are used in its treatment . “madness” was believed to be caused by obsessive thoughts, jealousy, and witchcraft (mal de ojo), and several rituals and herbal medicines were used in its treatment . (99-100)

**AZTEC MEDICINE**

Mesoamerica (MA), a term accepted by scholars to define a geographical region inhabited by indigenous peoples that share common cultural traits resulting from intense cultural interchange began with the Olmec civilization in the early preclassic period followed by the Teotihucans, Toltecs and Mayans and perished during the Nahoa empire. The advent of civilization in MA can be placed in the early second millenium BCE.

Medicine in Mesoamerican cultures began in the year 1,500 BC. Aztec Medicine is the sum of all Mesoamerican medicine and represented the culmination of a long tradition uniting the different cultural groups of MA. The Aztec doctors, the tepatiani or ticitl, well acquainted and experienced in diseases occurring in a particular locality, were excellent healers of wounds and fractures.They examined the patient and applied remedies or administered medicinal herbs in the treatment. There were also nahualli physicians who used horoscopes, predictions and religious ceremonies, in addition to secret ingredients for a cure. A degree of specialization existed in the Aztec medical profession, the surgeon tetecqui or texoxotla ticitl, the phlebotomist tezoc or teximani, the midwife tlamatqui or temixintiani ticiti, the apothecary papiani or panamacani; and totolpixqui who were devoted to the curing of turkeys.

The anatomical terminology of the Aztecs, showing a detailed nomenclature and knowledge of the exterior and the interior parts of the human body, have been the result of the extensive practice of human sacrifice by the priests teopixquis. The extraction of the heart and flaying of the victim with the distribution of parts of the body after cutting in pieces and carving for the ritual banquet, made the priest and communicants familiar with muscles, joints, bones, arteries, and veins, and the main viscera. The process of diagnosis was the result of the religious concept of disease, and involved practices related to horoscopy as much as religious ceremonies alongside medical exploration performed by the Aztec physicians, thought to be professionally gifted in identifying the pathological syndrome of the patient together with the supernatural influences affecting his case.

The idea of astrological supernatural influences upon the human being , depicted in the Zodiac signs and their relation to phlebotomy:

The glyph for cipactli alligator, earth symbol, is related to the liver,

ehecati wind to the lungs, calli house to the right eye,

cuetzpailin lizard to the buttock,

coatl serpent to the reproductive organs,

miquiztli death to the head,

mazati deer to the right leg,

tochtli rabbit to the left ear,

atl water to the hair,

itzcuintli dog to the nose,

ozomatli monkey to the left arm,

malinalli a twisted herb to the intestine,

acatl reed to the heart,

ocelotl jaguar to the left leg,

cuauhtli eagle to the right arm,

cozcacuauhtli vulture to the right ear,

ollin sign of movement to the tongue,

tecpatl flintstone to the teeth,

quiahuitl rain to the left eye, and

xochitl flower to the breasts.

In the treatment of burns, the affected surface was treated with a poultice made of nopal, teamoxtli, texiyotl , blended with honey and the yolk of egg which gave a binding texture to the plaster and protected natural healing. A similar idea existed in the treatment of wounds; the wound lips were first sewn with hair by interrupted suture and the stitches covered by a warm dressing which was repeatedly changed if inflammation occurred, but no change was made in the dressing if healing proceeded satisfactorily.

In the case of nasal wounds, when the organ was cut off and suture failed, a prosthesis made of convenient materials was applied to cover the fault. In the occlusive treatment, the wound after suture was quickly wrapped by application of latex ulli to form an adhesive dressing, in order that the air will not enter in the wound. Ulli was also used in the treatment of keloids by burning the deformed scars. The type of stitch was the interrupted suture, examples of which may still be seen in the Xipe totec sculptures and drawings.

A knee swelling, probably due to synovial fluid, was sectioned, with a lancet and a poultice of toloa or chichicquahuitl, was applied to the joint as well as in purulent abscesses of the breast and the enlargement of lymphatic glands either in the neck or in the groin. Wherever the location of a fracture is, its treatment was to press the area, stretch the bone to its original length and position, and join its broken ends; then a poultice made of pulverized cacacili root was applied to the surface of the fracture, and immobilization for twenty days,( an Aztec month), was recommended, using wooden splints pressed and bound tightly around the fracture with cords.

The powder of the herb xipetziuh mixed with the root iztac zazatic was applied locally in fractures of the spine and ribs, or hot baths, and with obsidian knives periosteotomies were performed in the exposed fractures or the heroic measure of foreign grafting in the bone by the application of a very resinous stick to be inserted within the bone, bound inside the incision and covered after suture with the vegetable remedies.Closely related to surgical practice, certain human mutilations were performed as a result of religious ceremonials or military and social standing.

Pregnant women were advised not to warm the abdomen to excess by getting near the fire or by exposure to the sun not to 'toast' the child; napping during the day could deform the child's face, and chewing tzictli or chewing-gum would induce in the child hardening of the palate and gums with consequent suckling difficulties. The midwife also advised sexual moderation in the early months of pregnancy to avoid miscarriage, and abstinence at the final stages, but at the same time they believed that lack of sexual activity with the husband would produce sickly and weak children. To look at something red would induce an abnormal podalic or shoulder presentation of the foetus, to look at a man who had been hanged would induce intrauterine strangulation of the foetus by the umbilical cord.

The temazcalli or steam bath house, was a therapeutic procedure among the Aztecs, combining the idea of bodily cleanliness with spiritual purification. A fire was made and water sprayed over the hot stones from the produced steam, which induced with the sweat a strong effect on the patients for at least thirty minutes; after that time the patient was taken out and received a shower of tepid or cold water. The use of sulphurous springs produced beneficial effects upon leprosies, and certain dermatoses due to the high sulphur content of the waters used in the bath. The psychotherapeutic procedures used in Aztec medicine have been approached under a religious bias. (101-104)

**INCA MEDICINE**

When people got sick in the Inca Empire, priests usually performed healing ceremonies over them. The Incas had sophisticated understanding of the medicinal properties of herbs and plants. They used quinine to cure cramps, chills, and many other ailments and the leaves of coca plant to numb people who were in pain. (Cocaine, is derived from the same plant) . Inca hunters dipped their arrows in a drug called curare that they extracted from a tropical vine , instantly paralyzed the muscles. With the animal paralyzed, hunters could easily get their arrows back. Curare is still used as an anesthetic that causes a patient to temporarily lose feeling in a particular part of the body . Inca surgeons performed amputations for medical purposes.

Archaeologists have made the discovery that the Incas practiced brain surgery on living patients and used bronze or copper knives, hammers, tweezers, and chisels to drill into the skull. They cut out a rectangular or circular hole, lifted out the hole, and went to work on the brain. Archaeologists have found hundreds of skulls with incisions of Inca neuro surgeons. Some of the skulls were operated on more than once, even five different surgeries to repair injuries to the head and to cure ailments such as chronic headaches and even epileps . In Inca medicine a large role was reserved for religion and magic but at the same time an extensive knowledge of medicinal plants was available.

As a consequence, healers cured with a mixture of medicinal plants and religious-magic ceremonies. The medical practitioner treats illness and makes attempts to cure a patient by applying medicinal plants and performing surgical operations, or with magic, religious incantations and prayers.The Incas had some specific ideas about the pathogenesis and the course of a disease . While the profound knowledge of medicinal plants was experienced . For the Incas a close relation existed between religion and magic on one side, and disease on the other.

Disease was seen as the result of a disturbed relationship with supernatural forces. Since a sin was accepted asthe cause of any disease, making a confession was considered as an effective means to cure diseases. The Incas were convinced of a strong involvement of religion and magic, not only in medicine but also in nearly all other aspects of life. For the Incas nearly all important and less important events, including diagnosis and prediction of the outcome of a disease, were preceded by divination.

The use of psychoactive substances facilitated the contact with supernatural forces who were thought to give information about future and hidden events among which the cause and course of disease. Finding the cause of sorcery that had led to a disease, or the answering of the question whether a sick person would recover or die, were only a few of the many applications of divination. Divination was made for the succession of the ruler, to answer the question whether and when a war had to be made, for the finding of criminals, to determine the time of sowing and harvest and in many other aspects of daily life by many different types of diviners. The treatment of a disease consisted, a religious-magic approach.

The Inca ideas about the origin of diseases meant that for the cure of a disease primarily the disturbed relation with supernatural forces had to be restored. All cures were accompanied by offerings and prayers, and diagnosis and prognosis were usually determined by divination, because of the belief that supernatural forces were involved in the cause of the disease and the person had caused the disease by magic spells. Incas were quite aware of the benevolent action of medicinal plants but they did not perform their cures without prayers nor magic incantations. Among the Incas both males and females could exert the profession of healer with the exception that the assistance in childbirth was the exclusive domain of females.

The Quechua name for these midwives was huachachik or huachachicuk, while in Aymara language their name was huahuachiti or yocachiyri. The name hampicamayoc is composed of hampi and camayoc. The word camayoc was a general indication for an official or functionary, while the

meaning of hampi was ‘medicine’, so the hampicamayoc was the official who dealing with medicines. . The meaning of hampi (or hanpi) was more than just medicine. In compound words it was used to denote a poison of botanical origin. Although the hampicamayoc used some magic and prayers during the cure, their specialty was the knowledge and application of medicinal plants. The selection of people to become a healer resembled that of priests, whose function required a thorough selection and education. These priests belonged to the upper social classes and had often ties with the royal family

Cranial surgery was of high quality as can be derived from the many recoveries after skull trepanation. Trepanation was the best-known part of pre-Columbian surgery because of the many skeletons which have survived the centuries and from which a large part was trepanned. On the pottery of pre-Inca Moche culture relatively persons with an amputated arm or leg, and sometimes provided with an artificial limb, were depicted. Osteological analyses of Moche skeletal remains have shown foot amputation with subsequent healing. Prevention of infection and inflammation was essential for a successful surgical intervention. Substances, such as menthol, tannins, certain saponins and resins are excellent antiseptics were used plants for externally in surgical treatments. (105)

**TOLTEC MEDİCİNE**

Toltec medicine, a profound and ancient tradition rooted in the rich cultural heritage of Mesoamerica, offers a unique approach to healing that intertwines spirituality, nature, and community. Toltec medicine was not merely a collection of remedies but a holistic approach to health that encompassed rituals, community practices, and a profound respect for nature.

The healing traditions were passed down orally, with shamans and healers playing a pivotal role in preserving and transmitting this knowledge. The cultural significance of Toltec medicine extends beyond individual healing; it is viewed as a communal practice that strengthens social bonds and fosters a shared identity.The core principles of Toltec medicine center around the idea of balance and the integration of various aspects of life. Key principles include:

* **Holistic Approach:** Toltec healing recognizes the interconnectedness of the physical, emotional, and spiritual realms. Healing is not limited to the body and encompasses the mind and spirit, addressing the root causes of ailments.
* **Respect for Nature:** The Toltecs held a deep reverence for nature and its healing properties. Herbal remedies and natural ingredients were integral to their healing practices, reflecting a symbiotic relationship with the environment.
* **Ritual and Ceremony:** Healing was often facilitated through rituals and ceremonies that invoked the presence of spiritual guides and deities. These practices served to create a sacred space for healing and transformation.
* **Energy Flow:** The Toltecs understood the importance of energy flow within the body and the universe. Blockages in this energy flow could lead to illness, and various techniques were employed to restore balance.
* **Community Involvement:** Healing was a communal activity, with the participation of family and community members. This collective aspect reinforced social bonds and provided emotional support for the individual undergoing healing.

These principles illustrate a comprehensive worldview that values harmony and interconnectedness, guiding the practices of Toltec healers , who utilized herbs and plants but also emphasising their spiritual connection to natur as a mediator between the spiritual and physical worlds and acknowledging the significance of dreams and visions as tools for understanding one's health and well-being.

While Andean healing traditions  focusing more on the concept of *ayni*, or reciprocity, which emphasizes the importance of giving and receiving in relationships with others and the natural World, Toltec medicine shared the idea of balance, placing more significant emphasis on the individual's journey and the role of personal responsibility in health. Despite these differences, the underlying themes of connection, respect for nature, and the importance of community are prevalent across indigenous healing practices.

Toltec medicine, rooted deeply in the ancient traditions of the Mesoamerican civilizations, particularly among the Toltecs of central Mexico, encompasses a rich tapestry of healing practices that blend spirituality, nature, and the profound wisdom of the ancestors. Their practices were not merely methods for physical healing but are holistic approaches that address the mind, body, and spirit as well. The focus on interconnectedness is central to Toltec philosophy, where the idea of balance plays a pivotal role in achieving wellness.

Herbal remedies form the foundation of Toltec healing practices, relying on the natural resources available in the environment. The Toltecs revered plants for their medicinal properties, believing that nature provides all the necessary tools for healing. They utilized a variety of herbs, roots, flowers, and other natural ingredients, each chosen for its specific therapeutic qualities. Knowledge of these plants was passed down through generations, often through oral traditions and experiential learning.

Key herbs in Toltec medicine include:

* Chaya (Cnidoscolus chayamansa): Known as the "Maya superfood," chaya is rich in nutrients and often used to boost energy and improve overall health.
* Tepezcohuite (Mimosa tenuiflora): This tree's bark is famous for its antiseptic and healing properties, particularly for skin ailments.
* Mexican Wild Sage (Salvia apiana):  used in purification rituals, to cleanse the spirit and promote healing.
* Olive Leaf (Olea europaea): Employed for its anti-inflammatory and antioxidant properties,

In addition to these herbs, Toltec healers created complex tinctures and poultices, combining multiple ingredients to enhance their efficacy. The preparation of these remedies was considered a sacred act, requiring intention and respect for the plants. The process involved rituals, such as prayers or chants, to invoke the healing powers of the natural world.The use of herbal remedies was not limited to physical ailments,emotional and psychological issues were also addressed through plant medicine. For instance, calming herbs likechamomile and passion flower were utilized to alleviate anxiety and promote relaxation, reflecting the Toltec understanding that emotional well-being was crucial for overall health.

Rituals were integral to Toltec medicine, serving as a bridge between the physical and spiritual realms. These ceremonies were designed to invoke the forces of nature and the ancestors, creating a sacred space for healing. They could range from simple blessings to elaborate ceremonies involving the entire community.One of the most revered rituals in Toltec medicine was the **temazcal** or sweat lodge ceremony. This ancient practice involved a small, dome-shaped structure where participants entered to undergo a ritual steam bath. The temazcal was symbol of the womb, representing rebirth and purification. During the ceremony, herbal infusions were poured onto heated stones, creating steam infused with the healing properties of the herbs. Participants engaged in meditative practices, prayers, and chants, aimed to cleanse the body, mind, and spirit.

Another significant ritual was the offering ceremony, where healers created altars adorned with flowers, fruits, and other natural elements to honor the spirits and the Earth. These offerings were made to express gratitude and ask for guidance and healing. The healer used sacred smoke from copal or other aromatic plants to cleanse the space and invite positive energies.

The cycle of the seasons also played a vital role in Toltec rituals. Ceremonies were timed with specific celestial events, such as solstices and equinoxes, to align the healing process with the natural rhythms of the universe. This connection to the cosmos reinforces the belief that healing is a communal, universal experience.

**Energy Healing Techniques**

Energy healing was a significant aspect of Toltec medicine, reflecting the belief that every being possesses a vital life force or energy that must be balanced for optimal health. Practitioners employed various techniques to manipulate and harmonize this energy within individuals. These practices drew from ancient wisdom and were adapted to suit the individual needs .

Another popular technique was **tonal healing**, which involved the use of sound, music, and vibration to adjust the energy frequencies within the body. Healers used instruments such as drums, rattles, and flutes, as well as their voices, to create sounds that resonate with the individual’s energy field. This practice not only promotes relaxation but also facilitates emotional release and spiritual awakening.

Another essential practice was breathwork, where controlled breathing techniques were employed to enhance the flow of life force energy. Breath was considered sacred in Toltec philosophy, and through intentional breathing, individuals could release blockages, reduce stress, and connect with their inner selves.Visualization and guided imagery were often used in conjunction with other techniques to promote healing. Healers guided individuals through visualizing their energy centers (chakras) and envisioning light or healing energy flowing through their bodies. This practice was believed to align and balance energies, facilitating physical and emotional healing.The integration of these energy healing techniques underscores the holistic nature of Toltec medicine, where the mind, body, and spirit are seen as interconnected entities. Each aspect must be addressed for true healing to occur, reflecting the comprehensive approach that defines Toltec practices.

Toltec medicine encompasses a holistic approach to healing , integrating herbal remedies with a focus on netural ingredients to promote physical and emotional well-being , rituals and sacred ceremonies to create a spritüal connection and invoque healing powers and energy healing techniques including tonal healing and breathwork to balance the life force within individuals. Healing practices in Toltec medicine are a harmonious blend of nature, spirituality, and community. They reflect an understanding of the interconnectedness of life and the belief in the inherent ability of individuals to heal themselves. Through the use of herbal remedies, sacred rituals, and energy techniques, Toltec medicine offers a profound framework for achieving health and well-being, making it a valuable part of the indigenous healing traditions.

**The Role of the Shaman in Toltec Medicine**

The complex and multifaceted role of the shaman in Toltec medicine is deeply rooted in ancient traditions and practices that date back thousands of years. Shamans serve as spiritual leaders, healers, and guides within their communities, employing a unique combination of knowledge, rituals, and natural resources to facilitate healing and maintain the balance between the physical and spiritual realms.

**Training and Initiation of Shamans**

The training of shamans in Toltec medicine is a rigorous and transformative process. The journey begins in childhood, as aspiring shamans exhibiting heightened sensitivity to the spiritual world or an innate ability to perceive energies that others cannot, are identified by their families or community elders. Early recognition sets the foundation for their future training and development. The training process involves both formal education and experiential learning. Young shamans are often mentored by established practitioners, who impart knowledge about herbal medicine, spiritual practices, and the intricate relationship between humans and nature. This mentorship allows the apprentices to gain firsthand experience in conducting rituals, understanding the properties of plants, and interpreting the spiritual messages they receive. Eventhough the initiation rites vary significantly across different communities, they all include intense physical and spiritual challenges involving fasting, isolation, and meditation, designed to test the apprentice's resolve and commitment and allow the aspiring shamans to confront their fears and deepen their connection to the spiritual world. The ultimate goal of these initiation ceremonies is to awaken the shaman's spiritual abilities and cultivate the strength needed to serve their community effectively.

**Shamanic Tools and Instruments**

Shamans utilize a variety of tools and instruments, each imbued with symbolic meaning and purpose to assist in channeling energy, facilitate communication with the spirit world, and enhance healing practices.

Some of the most common instruments include:

Drums: considered the heartbeat of the earth, they are used to induce trance states ,guide shamans into the spiritual realm to connect with spirits, ancestros and other dimensions.

Ratles : containing sacred objects such as Stones or seeds, which add vibrational qualities to enhance their effectiveness, they are used to cleanse the energy of a space, ward off negative influences and invoke spitrits.

Herbs and plants: Having an extensive knowledge of the medicinal properties of the plants, Shamans use them in healing ceremonies to cleanse , protect and heal both physical and emotional ailments.

Altars : as a sacred place, incorporating elements such as candles, crystals and offerings to honor the spirits, they serve as focal points for energy and intention during healing practices.

These tools are not merely physical objects; but the extensions of the shaman's spirit to serve as conduits for healing energy. Each tool is treated with reverence, reflecting the deep respect for the natural world and the spiritual dimensions where they navigate.

**Healing Journeys and Spiritual Guidance**

One of the most profound aspects of a shaman's role in Toltec medicine is their ability to undertake healing journeys. These journeys are deeply spiritual experiences where the shaman enters altered states of consciousness, often facilitated by drumming, meditation, or the use of entheogenic plants. During these journeys, shamans may travel to different realms, communicate with spirits, and seek guidance for their community. Healing journeys often involve several stages, including preparation, journeying, and integration. In the preparation phase, the shaman sets their intentions and gathers the necessary tools for the journey. This may involve creating a sacred space, calling on protective spirits, and conducting preliminary rituals to ensure a safe and successful experience.

Once in a trance state, the shaman embarks on their journey, navigating the spiritual landscape. They may encounter guiding spirits, ancestors, or symbolic representations of the issues that need to be addressed within their community. The insights gained during these journeys are invaluable, as they provide clarity on how to address physical, emotional, and spiritual ailments affecting individuals and the collective.The integration phase is critical, as it involves translating the insights gained during the journey into actionable guidance for the community. This may include conducting additional healing rituals, sharing the messages received, or offering personalized guidance to those in need. The shaman's ability to effectively integrate and communicate these insights is a testament to their training and spiritual maturity. Shamans in Toltec medicine serve not only as healers but also as custodians of knowledge and tradition. Their role is essential in maintaining the cultural identity and spiritual well-being of their communities. As modernity encroaches upon traditional practices, the role of shamans remains vital in preserving the wisdom of Toltec medicine and ensuring that these practices continue to thrive for future generations.

The profound and intricate role of the shaman in Toltec medicine is rooted in centuries of tradition and spiritual understanding. Through rigorous training, the use of sacred tools, and the undertaking of healing journeys, shamans fulfill a critical role in their communities. They bridge the gap between the physical and spiritual worlds, providing guidance, healing, and a sense of connection to the greater cosmos.

If gods and supernatural beings could cause disease, so could certain individuals. It was considered that there were individuals who, either by themselves or due to their function, possessed excess “soul energy”, to cause damage through the“mal de ojo” (evil eye) or “mirada pesada” (heavy stare) to another weak individual. İt is believed that the disease was caused by one or more coinciding factors:

by a foreign substance entering the patient’s body through magic;

by damage inflicted on the sick person’s totem ¨ ¨(their animal double);

by loss of tonalli (the vital breath and good ¨ star ¨ , in the sense of pre-determined fortune); and,

by airs ¨ of disease ¨ , nefarious influences that hover around human beings.

The Indians believed that the diseases associated with cold came from the mountains and the power to heal them would come from the same mountains. Therefore, those affected by these diseases should make offerings to this mountain. Nahua physicians described diseases as the result of dynamic changes in the conditions patient’s organism in which the aggressiveness of external agents and the patient’s environment intervened because they considered health the result of equilibrium, and when this equilibrium was lost, the result was disease. Diseases were considered a dynamic process. They individualised each case by emphasising both natural and supernatural causes. They divided diseases into those in which a foreign being or object has entered the patient’s body and those in which the patient has lost or had their mental capacities diminished. The stars also had an influence on the development of disease and in predicting an individual’s good or bad fortune. The ticitl knew about magic as applied to medicine, but in practice they did not use it alone. (106)

**AFRİCAN TRADİTİONAL MEDİCİNE** (TAM)

African traditional medicine is defined as one of the holistic health care system comprised of three levels of specializations namely divination, spiritualism, and herbalism.

**Herbalism** : use of herbal remedies (vegetable, animal, and mineral substances) is a part of Traditional African Medicine since ancient times.The herbal practitioners take an extensive questionary consisting of case history and examine the patient physically and every day physiological processes like appetite, digestion, urination, defacation, and sleep. The patient medical history and symptoms give an attention by the traditional healers. The prescription includes individualized herbs or combinational herbs, in form of tinctures, extracts, fractions, decoctions, distillates, snuffs, gruels, teas, syrups, pills, ointments, polutices, etc. Various parts are used in traditional herbalism like roots, bulbs, and rhizomes from various healing herbs like Acacia senegal (Leguminosae: Mimosoideae), Aloe ferox (Xanthorrhoeaceae), Artemisia herba-alba (Asteraceae), Aspalathus linearis (Fabaceae), Centella asiatica (Apiaceae), Catharanthus roseus (Apocynaceae), Cyclopia genistoides (Fabaceae), Harpagophytum procumbens (Pedaliaceae), Momordica charantia (Cucurbitaceae), Pelargonium sidoides (Geraniaceae). Some of those verbs are also used in modern medicine such as Aspirin (from willow bark), Quinine (From cinchona bark).

**Divination** is the spiritual healing process which is an act to contact between spirtual world and the mundane world for getting the guidance to heal. The traditional healers were known as diviners. As per the belief systems, divination is a part of witchcraft and is a sign of metaphysical curses to block ones’ living energy. The healing protocols in divination includes following of ancestor instructions and sacrifices to the spiritual world. The diagnosis in divination protocol includes dream interpretations like apperance of ancestors, nightmares, omens, owls in diseased patients.

The traditional healers through the secret knowledge of divination, interpret the dreams through the spiritual communication to spiritual world and but the healing also includes secret recipes of herbal bath, herbal decoctions, sacrifices, incantations and wearing of herbal parts as a protective medicine. The different procedures in the divination includes tarot card and readings, celetic ogham, Norse Runes, tasseography or tasseomancy, Pendulum readings, osteomancy, lithomancy, fullmoon water scrying, pshycic automatic writing.

**Spiritualism** concepts like prayers, invocations, or incantations that have been offered to some mysterious and powerful forces in the various belief concept system like exorcism, divination, libation etc., have been practiced to heal diseases. The spiritualism or spiritual healing, which is an important healing practices in traditional african medicine includes the following healing procedures:

**a.Spiritual protection**: Africans believe that unknown illnesses may be due to an attack by the evil spirits. In this case the spiritual healer prescribes talisman, charm, amulets, specially designed body marks, and a spiritual bath to drive evil spirits away. These rituals are helpul in driving off evil and dangerous dark spirtual forces or elements to ward off the evils or dangers that may have befallen a individual or family or community.

**b.Sacrifices:** Part of spiritual healing process, they are offered at the request of spirits, gods, and ancestors which include the sacrifice and burrial of various animals like dogs, cats, buffaloes etc. which are burried alive at midnight to save the individual from the evil attacks. Even these sacrifices include some secret herbs, in which the healers believe that without these herbs, the process of sacrifices is incomplete. In some parts of Africa like Southafrica, the sacrifices include human sacrifice of young child known as muti or ritual murder by spirtual healers for various beleifs.

**c.Spiritual cleansing (known as spiritual bat hor ritual sacrifice bath):** This remedy, which is prescribed to the disease person with procedure and how many times per day, includes secret herbal bath, holy water bath, and animal blood poured from head to toe. After this bath, the diseased individual is required to offer certain items for sacrifice or libation like dove, dog, cat, got, fowl etc., along with local gin, cola nut, eggs, and plain white, red, or black cloth. It is belief that these items after sacrifice will be taken by the Gods, who would guide the traditional healer for specific bath and specific item for sacrificing. All the specified things will be tied in cloth and thrown into flowing river after sacrifice and left to degrade or at the cross roads at the outskirts of community depending on the nature and severity of the case. The Hausa-Fulani women of Zaria, Nigeria practice these type of ritual bath with hot water splashes along with the twigs of tamarind or neem tree during cold or respiratory illness.

**d.Exorcism:** also a part of spiritual healing, it includes expelling demons or evil spirits from the person with illness. Africans believe that diseases like mental illnesses are considered are due to the possession of evil spirits. The skill of exorcism is only performed by the traditional leader or preist in the community and includes various rituals like rosary chanting, dances, drums, music, songs, bibilical verses, touches the ill person with animal tails, and other objects.

The other healing techniques in the spiritualism include libation, which is defined as the pouring of some liquids like gin, aromas on to the ground as an offering to get release from the illness due to karmic events and practiced through various techniques like invocation, supplication, and conclusion. The process of libation is to win over the evil wishes and curses by enemies. This includes pouring or offering various liquids to the ground along with prayers and chants.

In Africa, Traditional medicine is a healing belief system having its own health and disease concept. This is considered as a hidden treasure or knowledge that will pass from father to his only one beloved son of that family. The various healing concepts in Traditional African medicine (TAM) includes herbalism, surgery, bone setting, spinal manipulation, psychotheraphy, hydrotherapy, occultism, hydrotheraphy etc.

In the Traditional African Medicine, Illness, which is considered as disorder that having both natural and supernatural causes, must be treated by both physical and spiritual means, using various procedures like divination, incantations, animal sacrifice, exorcism, and herbs. The health care services provided by the healers are based on culture, religious background, knowledge attitudes, and their community beliefs. The traditional healers never expose their herbo-magical remedies to the other people.

The term “African traditional medicine” ( called African folk medicine or African indigenous medicine or African ethno-medicine) refers to the indigenous medicine of Africa, based on traditional indigenous knowledge systems and passed down, by word of mouth, from generation to generation within the particular indigenous community either along familial lines or apprenticeships. African traditional ethno-medicine medicine is holistic in approach and embraces the physical, mental, spiritual and social well-being. Ethnomedicine (indigenous medicine) and its ethno-pharmacology are based on traditional indigenous knowledge that has been passed down, by word of mouth, in particular cultural societies from generation to generation, often along kinship and familial lines- and remains largely either undocumented or unrecorded.

Traditional medicine refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination. The ATM doctors are classified into five groups even though they may have various names per the different languages and ethnic groups in Africa. Ccategories of ATM doctors will be considered: diviners, herbalists, traditional birth attendants, priest healers, and traditional surgeons.

**Diviners:** Diviners form an essential link between humans and the supernatural. They customarily diagnose illnesses by throwing cards, bones or stones, and by drawing lines on the floor with chalk while consulting their ancestors. In phraseology, this act of casting objects is referred to as a “floor X-ray”, because the diviner can diagnose the problem from the pattern formed by the fallen bones or stones. In a form of divination called the “mediumistic”, diviners are believed to be able to enter a trancelike state of altered consciousness which allows them to commune with their ancestors

**Herbalists**: Herbalists are people who have acquired extensive knowledge and experience in herbal medicine. They are able to prepare various medicines with plants, roots, barks, leaves, flowers, seeds, fruits, and parts or the whole of animals. Besides parts of plants and animals, herbalists utilize inorganic materials including chalks of various colours, salt, sulphur, alum, camphor, shells, pieces of rocks, and steel. They prepare and offer their herbal medicines in various forms such as powder that the patients can mix with other foodstuff or drink. The patients can rub the powder into cuts made with a sharp knife on any part of the body. The powdered preparation can also be mixed with native soap, which is then used for bathing, against skin diseases. Other medical materials are chopped and soaked for some time either in water or in local gin or boiled in water and then left to cool. This can be strained or decanted as required before drinking it. Because of their in-depth experience with herbs and their preparations, herbalists can be seen as traditional pharmacologists. In addition to possessing good knowledge of herbs, their preparation, administration and virtue, true herbalists respect and cooperate with the “workings of the natural laws, which are inseparable from the laws of health” for the well-being of their patients.

**Traditional Birth Attendants (TBAs**): TBAs assist with the delivery of babies. The members are predominantly women. WHO defines TBA as “a person who assists the mother during childbirth and who initially acquired her skills by delivering babies herself or by working with other TBAs” . Other roles of the TBAs include family planning, nutritional requirements, recommendations, screening of high-risk mothers, fertility/infertility treatment and determination of ailments or abnormalities relating to reproductive organs and reproduction. They also include care of childbearing mothers during pregnancy, labour, and post-natal periods; care of the infants in health and disease/sickness; recruitment of new acceptors into TBA practice; counselling responsibilities; and preservation and conservation of herbal plants and their derivatives.

**Priest Healers**: In addition to prescribing medicine, the priests, who function as priests, physicians, and psychologists, offer sacrifice and prayers on behalf of the community in times of calamities, such as drought, famine and wars. The priests, who include men and women, are chiefly intermediaries, standing between God, divinities, and human beings. Their duties are mainly religious; however, because Africans do not make much distinction between religion and other aspects of life, priests perform nonreligious functions as well. Lately, the prophets or faith healers, a post-colonial syncretism of Christianity joined this group. And divines and heals within the context of the African Independent Churches. They utilize prayer, candlelight, water, enemas, and inhaling the vapour of substances poured over heated stones.

**Traditional Surgeons and Bonesetters**: These people actually do not claim to be healers and perform various procedures, including incising and draining abscesses, uvulectomies to treat or prevent sore throats or chronic coughing, circumcisions, repair of inguinal hernias, intrauterine injections of a faecal fluid from pregnant cows to restore fertility, scarification to treat snake bite, noninvasive cataract luxation, adult tooth extraction, abortion, and cutting out the primary canine tooth buds of infants and toddlers to treat diarrhoea. Orthopaedic surgery is performed for closed and open fractures and osteomyelitis. Comminuted fractures are opened and explored. Bony fragments or devitalized bones are excised. Implant grafts of goat bones are sometimes used to replace excised bones. Splints of parallel sticks woven together with grasses or traction are used after internal or external reduction. Surgery is performed without anaesthesia. (107-109)

**Ethiopian traditional medicine (** ETM )

Ethiopian traditional medicine is not only concerned with curing of diseases but also consists of protection and promotion of human physical, spiritual, social, mental and material wellbeing. The concept of Ethiopian medicine is considered and kept as a hidden treasure, which will be passed orally from father to his favorite child. The various traditional practices include herbal medications, fumigation (inhalation), and Holy water or blessed water for pshyco social conditions. The traditional practices include Bone setting, Surgery, Cauterisation, Counter-irritation, Bleeding, Cupping, Steam Bath, Vapor Bath (woushba) and Moxibustion. The Ethiopian traditional medicine includes Orthodox healer (debetera), astrologer (Metsehaf Gelach), Mystique spiritual healer (Bale Zar), Divine healer (Psychi, Tenquay), Bone-setter (Woggesha), Kitab ketabi (Amult maker), Islamic Literature healer (Kabir), Islamic medical teacher (Sheki), and Cushitic healer (Qaalluu, Qaallicha, Argessa).

The practices in ETM consist of preventive, curative, and surgical care. Traditional Ethiopian medicine includes the prevention of diseases like small pox. It was prevented by the traditional healers in following the social distance protocol and vaccinating through innoculating by taking pus from sick person during special rituals. In case of preventive practices, the protocols like Sweeping or covering floors with particular plants was another traditionally practiced disease preventive measure.

The other methods of prevention included kitabs, which are also used for the purpose of protecting an individual against evil eye, as well as snake and scorpion bites since healers beleived that contagious disease is an evil act or causing by evil eye. The traditional healers also suggested Amulets, arm rings, hair style and eye make-up (antimony or kool) to protect from the evil eye. There are also some secret herbs useful as charms against an enemy. In addition, cultural rituals and sacrifices were involved in preventive care.

In curative practices of ETM, the diseases like gastrointestinal disturbance, respiratory disorders, sexually transmitted infections, tuberculosis, impotency, hemorrhoids, rabies, intestinal parasites, skin problems, liver diseases, mental disorders, hypertension, diabetes, gynecological conditions rheumatism, malaria etc. were treated using knowledge of traditional herbalism. The medhanit awakis (kitel betashs) herbalists, who use plants as their primary means of providing treatment, have their own traditional pharmacopeias. The surgical practices included traditional practices like bone-setting, uvulectomy, circumcisions, bleeding and cupping, cautery, scarification and tooth extraction. (110-112)

**ABORIGINAL BUSH MEDICINE**

The Aboriginal approach to health is holistic , encompassing the physical, personal and spiritual dimensions of life. A wide range of medical skills and treatments could be used for a variety of conditions including herbal medicines, ochre, diet, animal products, charcoal and mud, massages, amulets, smoke, steam and heat, the skills of the healer, and procedures to restore harmony. Traditions of healing have existed in Australia for some 65,000 years.

At the most basic level, people in the world recognise three main categories for the causes of illness: natural, human and supernatural . In many societies the origin of disease is perceived as a mixture of human and supernatural agencies and sickness is blamed on such things as sorcery, breaches of religious sanctions and social rules of behaviour, intrusions of spirits and disease-objects, or loss of soul. In Aboriginal Australia, the swift and inexplicable onset of serious illness was generally attributed to supernatural reasons.

Notions of health and sickness are shaped by entrenched cultural beliefs and traditions. Traditional Aboriginal notions of feeling sick with head pain explained in terms of sorcery or from a malevolent spirit having entered the head . Determination of the cause of an ailment leads to establishing how it is to be treated. In the Western Desert, healers deal with headaches by blowing their breath across the patient’s head to remove a foreign spirit or mamu, followed by neck massage and the manipulation of ‘strings’ believed to control the blood flow to the brain .Aboriginal people believe that the protection of an individual’s spirit is fundamental to their health. In Aboriginal Australia illness is sometimes associated with particular winds. Arrernte people consider that the northwest wind, aretharre, is the ‘bad one’ . It blows in early spring and people who suffer from its dust are treated with a healing song. It is a tradition of the Ngarinman people living in the Victoria River area in the Northern Territory that serious colds originate from a place associated with the Bad Cold Dreaming .

Aboriginal people believe that the disruption of the power surrounding religious places or sites will cause serious illness to their spirit . In desert Aboriginal communities reasoned that people suffering from hunger and thirst will have a hot heart, which can be made cooler by drinking water and the notion of being cold is the essential concept of Aboriginal health and well-being. The consumption of animal blood is widely believed in desert communities to help in ‘cooling’ the body . Related to this belief, red ochre, which is typically associated with the ‘blood’ of spirit of Ancestors combined with fat, is applied to the body for a ‘cooling’ effect. When the heart and spirit are considered ‘hot’, it is thought that this condition will affect other parts of the body, particularly the head.

Desert dwellers express the health condition of individuals in terms of hotness and coldness. Aboriginal people in the northern deserts consider that the roots of young ‘wild curry’ kurrajong (Brachychiton multicaulis) trees are a ‘cool food’, because eating them makes you feel refreshed . In northern Australia the treatment for headaches caused by hunger, thirst or sickness, is to wrap the head with snakevine (Tinospora smilacina) stem. The woody climber has a milky latex sap with a cooling property utilised to treat various ailments .

Aboriginal people consume tonics to maintain their general health and body function. To invigorate themselves, Aboriginal people in southern South Australia , take ‘blood medicine’ made from thistle (Sonchus species) stems or pale flax-lily (Dianella longifolia) roots .Tonics are taken to maintain good health. Aboriginal societies place great faith in their own healers, who they believe have special powers derived from their spiritual Ancestors to cure the sick. In many varieties of Aboriginal English the healers are called ‘clever men’ or ‘powered men’, although these terms include other spiritually powerful people such as rain-makers and sorcerers. Healers are considered to have the ability to ‘see’ into the body of their patients. They deal with emotional problems as well as physical ones. An Aboriginal healer’s closest equivalent in contemporary Western European medicine would be a professional who is both a general practitioner and a psychiatrist. There are many different Aboriginal language terms for healers across Australia, such as ngangkari in the contemporary Western Desert , marrnggitj in northeast Arnhem LaIn Aboriginal Australia. The healer’s job is to diagnose problems, advise on remedies, suggest and perform ritualised healing procedures, explore the impact of community social and cultural issues upon the illness, and to reassure their patients that they can be cured. Most recognised healers are men, although people of both genders have a wide general knowledge of efficacious healing plants. While the healers focus upon treating sick individuals, women specialise in performing ceremonies that promote the general health and wellbeing of their whole family.

All adults in the community would have known about basic medicines, but healers were considered to have special access to spiritual powers and assistance. The healer’s set of special skills was considered fundamental for treatment in cases where sickness was blamed upon supernatural things, such as sorcery, contact with spirits and the breaking of taboos. When illness is diagnosed as being caused by foreign objects entering the body, the healers treat the patient with singing, massage and sucking to ‘remove’ the offending article, which may be revealed as a fragment of wood, bone, shell, stone and even wire or glass .Healers may ‘insert’ special objects into the patient to affect a cure. In Aboriginal English certain places or areas that make people ill are referred to as ‘sickness country’ . ‘Devil devil business’ was the stated cause for the most serious and otherwise unexplained illnesses . Healers draw upon the ancestral powers of their kinship network when treating the seriously ill.

Ramindjeri people had ‘doctors’ who appealed to the object, animal or plant that was their

totemic ‘friend’ or spirit familiar such as a snake or an ant or seaweed. In the southern Kimberley and northern Western Desert, a traditional ‘doctor’ receives his power from dreams or by obtaining magical charms, maban, and enters the patient’s body to do the work. Some maban are even considered invisible. In the southern Western Desert, healers use charms called mapanpa, which may be comprised of pieces of wood, stone, bone and other objects . Each healer has an own set of such ‘sacred tools’. There are many ways in which Aboriginal people become healers , generally through special training, commencing when still a youth, into the methodology and rituals related to discerning causes of illness, and involves spiritual revelation. The role of healer is rarely passed down directly from father to son, instead chosen for their developing social skills and an aptitude for learning. Aboriginal healers observe specific taboos believed to maintain their powers. In many regions, particularly Central Australia and parts of the Kimberley, healers avoid such things as bites from large ants, excessive eating of fat and the drinking of any hot beverages, through their fear of losing power. It was a recorded custom in a part of western New South Wales that ‘medicine men’ could never eat their individual totemic animal or plant . Across southeastern Australia after European settlement, ‘clever men’ were said to lose their healing and psychic abilities, such as knowing in advance who was about to arrive, through drinking too much alcohol.

Aboriginal remedies are used to relieve symptoms such as fever, congestion, headache, skin sores, tired or swollen aching limbs and digestive problems. Treatment involve drinks, washes, massages and aromatherapies. The drinks are made by heating water with plant additives, and in Aboriginal English are commonly referred to as ‘tea’. Some plants are heated, then rubbed or massaged into swollen parts of the patient’s body. The aroma of plants is transferred to the patient through contact with steam and smoke. It was important for Aboriginal people to know the seasonality of each plant species, some of which may not be as effective or even available at certain times of the year.

Aboriginal mental health represents a critical aspect of understanding the holistic well-being practices of indigenous communities. Traditional Aboriginal approaches to health and wellness by emphasizing a holistic view that integrates health’s physical, emotional, spiritual, and social dimensions. One notable model that exemplifies this approach is the Dance of Life, which underscores the interconnectedness of these various health aspects. The Dance of Life model, rooted in Aboriginal spirituality and cultural practices, highlights the importance of rituals, storytelling, and community support in maintaining mental health.

Rituals and storytelling serve as therapeutic practices and as means of preserving cultural identity and continuity, which are essential for mental well-being.  Another model likens health to the 4 walls of a house, with each wall representing a different dimension of health: taha tinana (physical health), taha wairua (spiritual health), taha hinengaro (mental health), and taha whānau (family health). Since imbalance can affect overall well-being, promoting a holistic approach to health care should incorporate physical, spiritual, mental, and social elements. In Aboriginal communities, mental health is deeply intertwined with cultural identity and community connections with cultural practices and traditional knowledge leads to healing and improving mental health outcomes. Programs incorporating traditional healing practices, such as bush medicine, traditional diets, and spiritual ceremonies, have positively affected mental health by reinforcing cultural identity and community ties. Intergenerational transmission of knowledge and practices is fundamental to maintaining the cultural continuity and mental health of Aboriginal peoples.

Aboriginal Community Controlled Health Services (ACCHSs) are designed to provide culturally safe and relevant health care that addresses the specific needs of Aboriginal communities. These services incorporate traditional healing practices and cultural elements into their mental health programs, recognizing the importance of a holistic approach to health. The integration of traditional and Western medical practices in ACCHSs exemplifies the potential for culturally responsive healthcare models to improve mental health outcomes for Aboriginal people.

 In addition to these culturally specific models and practices, it is essential to consider the broader social determinants of health that impact Aboriginal mental health. Factors such as poverty, unemployment, housing instability, and education disparities play significant roles in shaping the mental health of Aboriginal individuals and communities. Addressing these social determinants through policies and programs that promote equity and social justice is critical for improving mental health outcomes. The intersection of these social determinants with cultural practices highlights the need for a comprehensive mental health care approach that addresses individual and structural factors.

Programs incorporating traditional healing practices, such as healing circles, sweat lodges, and storytelling, offer pathways for addressing trauma and fostering resilience within Aboriginal communities. There has been a growing recognition of the importance of land and connection to the country in Aboriginal mental health. The concept of “country” extends beyond physical land to encompass the spiritual, cultural, and social connections that Aboriginal people have with their ancestral lands. Connection to the country is a source of strength, identity, and well-being.  Programs that facilitate reconnection with land, such as cultural camps and land management projects, have been shown to improve mental health outcomes by fostering a sense of belonging and cultural continuity. These programs highlight the importance of integrating environmental and cultural dimensions into mental health care for Aboriginal peoples. The relationship between climate and health is another critical aspect that intersects with Aboriginal mental health. Many Aboriginal communities are particularly vulnerable to the impacts of climate change, which can exacerbate existing health disparities. Environmental changes, such as shifts in weather patterns, loss of biodiversity, and degradation of natural resources, can directly and indirectly affect mental health. For instance, losing traditional food sources and medicinal plants due to climate change can impact physical and mental well-being.

Additionally, the displacement caused by environmental changes can disrupt community cohesion and cultural practices, further affecting mental health. Traditional ecological knowledge (TEK) held by Aboriginal communities offers valuable insights into sustainable land management and climate adaptation practices. Integrating TEK into environmental and health policies can enhance resilience and improve mental health outcomes by promoting sustainable practices that align with cultural values. Collaborative efforts that involve Aboriginal communities in climate adaptation planning and environmental stewardship can foster a sense of agency and empowerment, which are important for mental health. (113-115)

**EVIDENCE BASED MIND-BODY MEDICINE**

Bridging the gap between spiritual and rational medical approaches has been crucial in evolving healthcare practices. Ancient healing systems often combined empirical observations with spiritual beliefs, creating a holistic understanding of health that addressed physical and metaphysical aspects of well-being. This synthesis of spiritual and rational approaches continues to influence contemporary medicine, fostering integrative practices that aim to treat the whole person.

Ancient healing practices, spanning cultures and civilizations across the globe, share common themes and principles while reflecting the unique cultural, philosophical, and environmental contexts in which they developed. A comparative analysis of these healing traditions reveals similarities and differences in their health, illness, and healing approaches. One of the fundamental similarities among ancient healing practices is their holistic understanding of health, which encompasses the interconnectedness of body, mind, and spirit. Whether the Hippocratic physicians, the Ayurvedic healers of ancient India, or the traditional healers of indigenous cultures, holistic health is central to their understanding of well-being. Ancient healers recognized that physical symptoms of illness are often intertwined with psychological, social, and spiritual factors. They sought to address the root causes of the disease rather than merely treating its symptoms. Another common feature of ancient healing practices is using natural remedies derived from plants, minerals, and animal substances. Herbal medicine, in particular, plays a prominent role in many traditional healing systems, with medicinal plants being valued for their therapeutic properties and healing potential.

**COMPARISON OF TCM AND AYURVEDA**

Ayurveda and TCM have many commonalities. The focus of both the systems is on the patient rather than disease. Both systems fundamentally aim to promote health and enhance the quality of life, with therapeutic strategies for treatment of specific diseases or symptoms in holistic fashion. Both systems have similar philosophies geared towards enabling classification of individuals, materials and diseases. TCM considers the human at the center of the universe as an antenna between celestial and earthly elements. Water, earth, metal, wood and fire are the five elements of the material world. The world is a single unit and its movement gives rise to yin and yang, the two main antithetic aspects. The actual meaning of the term yin and yang is ‘opposites’, such as the positive and the negative. The four bodily humors (qi, blood, moisture and essence) and internal organ systems (zang fu) play an important role in balancing the yin and yang in human body. Proper formation, maintenance and circulation of these energies are essential for health.

When the two energies fall out of harmony, disease develops. The physician takes into account this concept while treating patients. Drugs or herbs are used to correct this imbalance of yin–yang in the human body.Ayurveda considers that the universe is made up of combinations of the five elements (pancha mahabhutas). These are akasha (ether), vayu (air), teja (fire), aap (water) and prithvi (earth). The five elements can be seen to exist in the material universe at all scales of life and in both organic and inorganic things. In biological system, such as humans, elements are coded into three forces, which govern all life processes. These three forces (kapha, pitta and vata) are known as the three doshas or simply the tridosha. Each of the doshas is composed of one or two elements. Vata is composed of space and air, Pitta of fire, and kapha of water and earth. Vata dosha has the mobility and quickness of space and air; pitta dosha the metabolic qualities of fire; kapha dosha the stability and solidity of water and earth. The tridosha regulates every physiological and psychological process in the living organism. The interplay among them determines the qualities and conditions of the individual. A harmonious state of the three doshas creates balance and health; an imbalance, which might be an excess (vriddhi) or deficiency (kshaya), manifests as a sign or symptom of disease.

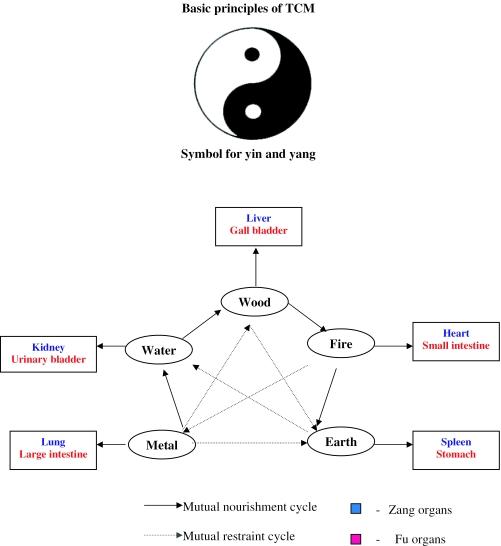


Fig.16. Basic Principles of TCM.

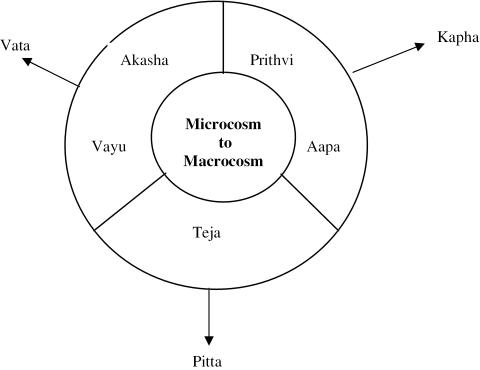


Fig.17. Basic principles of TIM.

Where they differ strongly, is in the diagnosis and the classification of disease. In Chinese medicine there is channel theory, Five Element theory, and zhang/fu patterns that classify disease. In Ayurveda, the focus is on balancing the three dosha ( vata, pitta, and kapha,) dynamic forces whose interplay governs all aspects of human physiology: body, mind, and spirit. Vata governs all movement of the body, from locomotion to electrolytes moving in and out of the cell, and is associated with the mind and intestines. It is born from the elements of Air and Ether, which combine to form vata when a human is conceived. Pitta, made of Fire and Water, controls the body’s heat and all aspects of digestion and transformation. Lastly, kapha governs all fluids, lubrication, and growth of the body, and is the product of Water and Earth. Chinese medicine positing that the five phases of nature are Earth, Fire, Water, Wood, and Metal, whereas Ayurveda states that they are Earth, Fire, Water, Air, and Ether ( understood as “the space between matter”). In Ayurveda, Air dominates the joints and promotes movement; the Wood element of Chinese medicine does the same, and is also associated specifically with Wind, a clear manifestation of kinetic Air. In Chinese medicine, the Metal element is associated with spaciousness, purity, and the heavens—not dissimilar from Ether’s concepts of space. Ether is associated with the ears, hearing, and essence, which in Chinese medicine are more closely tied to the Water element.

In Ayurveda, the channels are referred to as *srotas* (or *nadi)*while in Chinese medicine they are referred to as the *jing luo* or meridians. Both disciplines use terminology associated with waterways, such as rivers and oceans with distinct pools of energy, or places where energy can be influenced known as *marma*points, or in Chinese, *xuè dào*. There are differences however; Chinese medicine’s system includes the 12 primary channels, the 12 divergent channels, and the 8 extraordinary channels that are often complemented by the 15 luo-connecting channels and 12 sinew channels. Meanwhile, in Ayurveda, the *srotas* are divided into channels based on the physical substance they carry or the tissue type the channel nurtures, such as transporting water (*udaka vaha srotas*) or supplying nutrition to the bones, nerves, and brain (*majja vaha srotas*). Lastly, three *srotas* are devoted to the elimination of metabolic wastes: one each for feces, urine, and sweat. All said, there are between 13 and 16 *srotas,* depending on the text consulted. Chinese medicine has 361 points, while Ayurveda lists only 107 *marma* points.

Ayurveda identifies six tastes and TCM identifies five. Ayurveda’s additional taste is astringen.

Ayurveda tastes are combinations of two elements, while in TCM each taste resonates with one element. The two systems are in agreement of the effects of the tastes, with the exception of salt. Ayurveda gives it a heating quality, while TCM identifies it as cooling. TIM theorizes that all the elements constitute every tissue, every organ, whereas TCM ascribes one element to one organ, namely wood to liver etc.

The historical, cultural and social foundations of the Asian states were cultivated on top of the three main philosophical traditions, the Vedic philosophy (giving rise to Ayurveda), Taoism (giving rise to TCM) and Confucianism. Ayurveda and the Vedic philosophy are predominant in the West Asian countries (India, Pakistan, Tibet, etc.), whereas TCM is practiced in the East Asian countries (China, Korea, Japan, Vietnam, etc.) .

TCM therapy begins with the evaluation and differentiation of syndrome (or the identification of disease patterns) , whereas the constitutional typing and determination of the constitutional proclivity are the first steps in Ayurveda therapy. TCM medicinal herbs are classified according to the therapeutic effects of the herb itself, namely, dispersive quality, Yin tonifying quality and so forth. A particular medicinal herb can be applied to any patient afflicted with the same disease or pathology regardless of the individual’s constitutional type. Ayurvedic therapeutics are based on constitutional approach, and the medicinal herbs are selected or excluded according to their compatibility or incompatibility to the constitutional makeup of a given individual. Ayurvedic medicinal herbs are distinguished by their effects on the three *doshas*.

From the medicinal herbs of Ayurveda to the botanical remedies of traditional Chinese medicine, ancient healers relied on the healing power of nature to treat a wide range of ailments and promote overall wellness. In addition to herbal remedies, many ancient healing traditions incorporate dietary interventions, lifestyle modifications, and mind-body practices to promote health and prevent disease. Dietetics, for example, is a key component of both Ayurvedic medicine and traditional Chinese medicine, with emphasis placed on eating according to one’s constitution, balancing the 6 tastes, and harmonizing the body’s internal environment.

Similarly, practices such as yoga meditation, and qigong are used in Ayurveda, traditional Chinese medicine, and other healing traditions to cultivate mindfulness, reduce stress, and promote emotional well-being. Another shared characteristic among ancient healing practices is diagnostic techniques based on observation, palpation, and questioning to assess health and identify disharmony or imbalance patterns. Whether pulse diagnosis in TCM, tongue diagnosis in Ayurveda, or symptomatology in Hippocratic medicine, ancient healers employed various diagnostic methods to gain insight into the underlying causes of illness and guide their treatment strategies.

While Ayurveda, rooted in the philosophical traditions of Hinduism, emphasizes the balance of the 3 doshas (Vata, pitta, kapha) and the importance of individualized treatment plans based on each person’s unique constitution (Prakriti), Traditional Chinese medicine, on the other hand, is based on the principles of yin and yang, the 5 elements (wood, fire, earth, metal, water), and the flow of qi (vital energy) through meridians or channels in the body. Ayurveda and TCM utilize herbal medicine, acupuncture, and dietary therapy, but they have distinct pharmacopeias, acupuncture points, and dietary recommendations based on their respective cultural contexts and geographical regions. While Ayurvedic herbal formulas include spices such as turmeric, ginger, and cinnamon, traditional Chinese herbal formulas incorporate botanicals such as ginseng, licorice, and astragalus. Regarding therapeutic modalities, Ayurveda strongly emphasizes purification and detoxification therapies known as panchakarma, which aim to cleanse the body of accumulated toxins (ama) and restore balance to the doshas. TCM, on the other hand, utilizes techniques such as acupuncture, moxibustion, cupping, and tuina massage to regulate the flow of qi and blood, harmonize yin and yang, and promote the body’s innate healing mechanisms.

The cultural context in which ancient healing practices developed also influences their philosophical underpinnings, diagnostic methods, and treatment approaches. For example, the Hippocratic physicians were influenced by the philosophical traditions of rationalism, empiricism, and naturalism, which shaped their approach to medicine as a science based on observation, logic, and reason. Ayurveda and traditional Chinese medicine emerged within the cultural and spiritual frameworks of Hinduism, Buddhism, and Daoism, emphasizing the interconnectedness of all living beings and the importance of harmony with nature.

Ancient healing practices share a common goal of promoting health, preventing illness, and alleviating suffering through a holistic and compassionate approach to care. Whether the ancient physicians of Anatolia, India, China, or indigenous cultures, the legacy of their wisdom and healing traditions continues to inspire and inform modern healthcare practices worldwide. Cross-cultural exchanges and influences have played a significant role in the development and evolution of medicine throughout history, facilitating the exchange of knowledge, ideas, and practices across diverse cultures and civilizations.

One of the earliest examples of cross-cultural exchange in medicine can be seen along the Silk Road, an ancient network of trade routes that connected East Asia with the Middle East, South Asia, and Europe. Along these routes, merchants, travelers, and scholars exchanged goods, ideas, and knowledge, including medical remedies, techniques, and philosophies. From the ancient Silk Road trade routes to the modern era of globalization, interactions between different societies have enriched medical traditions, expanded therapeutic options, and fostered collaboration and innovation in healthcare.  Chinese medicine, emphasizing herbal medicine, acupuncture, and qigong, spread westward along the Silk Road, influencing medical practices in Central Asia, Persia, and the Arab world. Indian Ayurvedic medicine, with its holistic approach to health and wellness, found its way to the West via trade and cultural exchange, influencing medical traditions in Rome, and beyond. In TCM, health is viewed as a balance between yin and yang, 2 opposing forces representing different aspects of the natural world. Illness is seen as a disruption of this balance, and treatments aim to restore harmony within the body and with the external environment. Acupuncture, herbal medicine, and qigong are commonly used therapies in TCM, each based on energy flow (qi) principles and the interconnectedness of the body’s systems. Taoist philosophy profoundly influences these practices, emphasizing the cyclical nature of existence and the importance of living according to the natural order.

In Ayurveda, the traditional medicine of India, health is viewed as a dynamic equilibrium between the 3 doshas, or bodily energies: vata, pitta, and kapha. Each person has a unique constitution, or Prakriti, determining their susceptibility to illness and optimal healing path. Ayurvedic treatments include dietary recommendations, herbal remedies, massage, and meditation, all aimed at restoring balance within the body and promoting overall well-being. Ayurveda is deeply rooted in Hinduism and the concept of dharma, or righteous living, which emphasizes the interconnectedness of the individual, society, and the cosmos.(116-117)

**Islamıc medıcıne**

Islamic physicians were strongly influenced by Galen and Hippocrates and translated their voluminous writings from Greek into Arabic and then produced new medical knowledge based on those texts. In order to make the Greek tradition more accessible, understandable, and teachable, Islamic scholars ordered and made more systematic the vast and sometimes inconsistent Greco-Roman medical knowledge by writing encyclopedias and summaries. It was through reading Arabic versions that Western doctors learned the works of Hippocrates and Galen.

Medieval and early modern scholars in Europe drew upon Islamic traditions and translations as the foundation for their medical enterprise. Ibn Sina’s masterpiece, Al-Qanun fi al-Tibb (The Canon of Medicine) had a vast influence on medical teaching in the West as well as in the Arab world. As definitive encyclopedia, it remained a standard medical textbook in Europe for 500 years—from the 12th to the 17th century—earning Ibn Sina the title of Prince of Physicians. Ibn Sina’s Canon—a massive book containing a million words across five volumes—is a collection of all that was known at the time about medicine and surgery, including the doctrines of Hippocrates and Galen . The first volume dealt with the origins of health and sickness and aspects of the body’s anatomy and function. The second volume listed information on more than 700 drugs and medicines. The third volume covered the diagnosis and treatment of diseases specific to certain parts of the body, while the fourth focused on conditions that affect the whole body. The final volume discussed the preparation of medicinal remedies. The Canon was translated into Latin in the 1100s and consequently came to dominate approaches to medicine. During the 15th and 16th centuries alone, the *Canon of Medicine* was published more than 35 times. It was the most influential medical book of the Middle Ages.

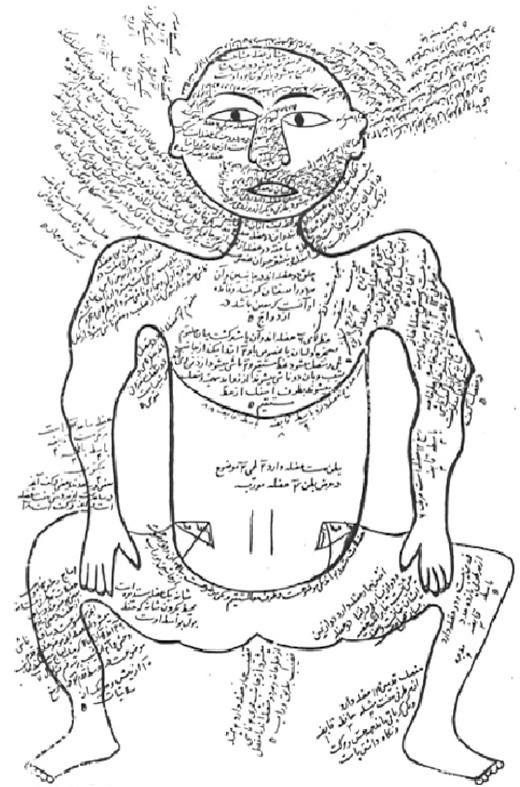


Fig.18. Muscle figüre, shown frontally , with extensive text denoting muscles. From the anatomy of human body (Tashrih –ibadan-i insan ) written at the end of 14 th century. All then majör arabic encyclopedias had sections on anatomy, summarizing the Galenic anatomical concepts. Islamic culture and Medical arts, US National Library of Medicine. The major contribution of the Islamic Age to the history of medicine was the establishment of hospitals, paid for by the charitable donations. These hospitals, as well as providing care to the sick on site, sent physicians and midwives into the poorer, rural areas, and also provided a place for physicians and other staff to study and research. These hospitals varied in role, some aimed at serving the general population, with others providing specific services, such as the care of lepers, the disabled and the infirm.

The system of educating physicians was well structured, usually on a tutorage basis, and the reputation of the individual physicians in certain areas ensured that students would travel from city to city to learn with the best. In addition, the Islamic physicians were meticulous with their recordkeeping, partly as a way to spread and share knowledge, but also to provide notes for [peer review](https://explorable.com/peer-review-process) in case the physician was accused of malpractice.

The Islamic Golden Age, from the 8th to the 14th centuries, was a period of significant cross-cultural exchange and innovation in medicine. Islamic scholars and physicians preserved, translated, and synthesized the medical knowledge of ancient civilizations, including the Greeks, Romans, Persians, Indians, and Chinese, creating a rich and diverse medical tradition known as Islamic medicine or Arabic medicine. Works such as the Canon of Medicine by Avicenna (Ibn Sina) and the Al-Tasrif by Al-Zahrawi (Albucasis) became foundational texts in medieval medical education and practice, influencing medical thought in Europe and beyond.

Rediscovering classical Greek and Roman texts and translating Arabic medical works during the European Renaissance sparked a revival of interest in ancient medical knowledge. They paved the way for the development of modern Western medicine. Scholars such as Andreas Vesalius, William Harvey, and Paracelsus drew upon the insights of ancient and Islamic medicine to advance the fields of anatomy, physiology, and pharmacology, laying the groundwork for the scientific revolution in healthcare.

The works of Hippocrates, Galen, and Avicenna became foundational texts in medical education, shaping the training and practice of physicians for centuries to come. In colonial and postcolonial contexts, cross-cultural exchanges in medicine often took on a different character, marked by power imbalances, exploitation, and resistance. European colonial powers imposed their medical practices and ideologies on colonized populations, often at the expense of indigenous healing traditions and knowledge systems. Traditional healers and indigenous medical practices were marginalized, stigmatized, or suppressed in favor of Western biomedicine, leading to the erosion of cultural identities and the loss of traditional healing knowledge. (118-120)

Efforts to reclaim indigenous knowledge and practices have emerged in recent years, highlighting the importance of cultural diversity and the need for decolonizing healthcare systems. In the modern era of globalization, cross-cultural exchanges in medicine continue to shape healthcare practices and policies around the world. Advances in communication, transportation, and technology have facilitated the exchange of medical information, expertise, and resources across borders, enabling collaboration and innovation in healthcare delivery, research, and education. International partnerships and initiatives work to address global health challenges, promote health equity, and strengthen healthcare systems in underserved communities.

At the same time, globalization has also led to the commodification and commercialization of healthcare, with pharmaceutical companies, medical device manufacturers, and healthcare providers seeking to expand their markets and maximize profits. This has raised concerns about the influence of multinational corporations on healthcare policies, access to essential medicines, and the prioritization of profit over public health. Efforts to promote ethical practices, transparency, and social responsibility in healthcare ensure that cross-cultural medical exchanges benefit all stakeholders and contribute to the well-being of individuals and communities worldwide.

The impact of ancient healing practices on contemporary healthcare systems is profound and multifaceted, reflecting a blend of traditional wisdom and modern scientific advancements. Integrating ancient medical knowledge with contemporary biomedical approaches has enriched healthcare delivery, expanded therapeutic options, and promoted a more holistic understanding of health and well-being.  One significant impact of ancient healing practices on contemporary healthcare is the resurgence of interest in holistic and integrative medicine. Ancient medical systems such as Ayurveda, TCM, and various indigenous healing practices emphasize the interconnectedness of the body, mind, and spirit. These systems advocate for treating the whole person rather than just addressing isolated symptoms. Contemporary healthcare has increasingly adopted this holistic approach, recognizing the importance of psychological, social, and spiritual factors in health and disease. The use of medicinal plants and natural products has been a cornerstone of traditional healing systems across the globe. Modern pharmacology and drug development have often drawn upon this rich repository of botanical knowledge. For instance, the antimalarial drug artemisinin, derived from the Chinese herb Artemisia annua, has become a critical component in treating malaria worldwide. Similarly, the anticancer drug paclitaxel (Taxol), originally isolated from the Pacific yew tree, highlights the enduring relevance of traditional plant-based remedies in contemporary medicine.

The principles and practices of Ayurveda and TCM have also been integrated into modern preventive medicine and wellness strategies. Both systems emphasize the importance of lifestyle factors, including diet, exercise, and stress management, in maintaining health and preventing disease. The Ayurvedic concept of “dinacharya” (daily routine) and the TCM focus on balance and harmony have influenced contemporary approaches to wellness, encouraging individuals to adopt healthier lifestyles to enhance their overall well-being.

Yoga, tai chi, and qigong originated from these ancient systems are now widely practiced worldwide for their physical, mental, and emotional benefits. Diagnostic techniques from ancient healing practices have also made their way into contemporary healthcare, offering valuable insights and complementary methods to modern diagnostic tools. For example, pulse diagnosis in TCM, which assesses the quality and rhythm of the pulse to determine health status, has been explored in contemporary research for its potential to provide additional diagnostic information. Similarly, the Ayurvedic practice of examining the tongue and other physical signs to assess dosha imbalances has been incorporated into some holistic health assessments, providing a broader perspective on a patient’s health.

The ethical principles and professional conduct outlined in ancient medical traditions continue to resonate in contemporary medical practice. The Hippocratic Oath, remains a foundational ethical guide for modern physicians, emphasizing non-maleficence, beneficence, and confidentiality. These ethical standards underscore the timeless values of compassion, integrity, and respect for patients, which are central to medicine today. While many traditional therapies have been used for centuries with anecdotal success, their integration into modern healthcare requires evidence-based research to meet the standards of contemporary medical practice. This necessitates collaboration between traditional healers, biomedical researchers, and healthcare providers to conduct high-quality studies and clinical trials.

Another challenge is the potential for cultural misappropriation and commercialization of traditional knowledge. As traditional healing practices gain popularity, there is a risk of exploiting indigenous knowledge without proper acknowledgments, respect, and benefit-sharing with the communities that have preserved these traditions for generations. Ethical considerations and policies must be in place to protect the intellectual property rights of indigenous peoples and ensure that the benefits of integrating traditional knowledge into contemporary healthcare are shared equitably.

Despite these challenges, integrating ancient healing practices into contemporary healthcare systems offers significant opportunities for improving health outcomes and patient satisfaction. By embracing a more holistic and patient-centered approach, healthcare providers can address patients’ diverse needs and preferences, fostering a more inclusive and culturally sensitive healthcare environment. This approach can also enhance the therapeutic relationship between patients and healthcare providers, promoting trust, communication, and collaboration in healing.

**Climate change and health**

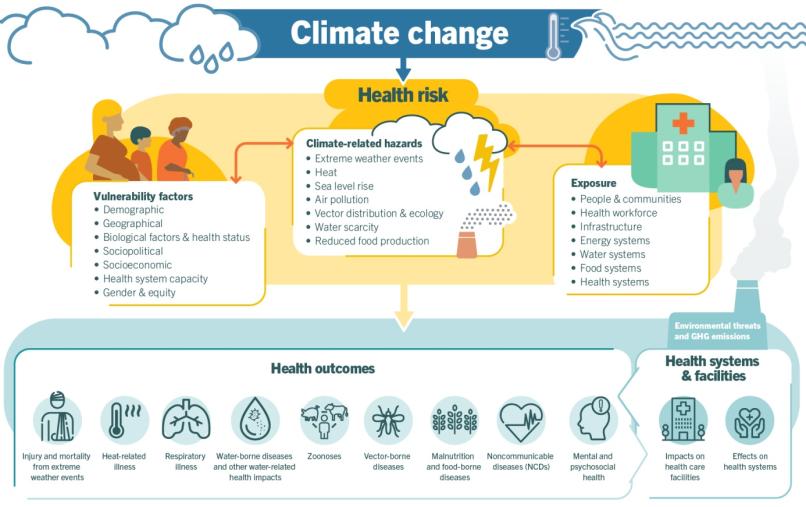
The relationship between climate and health is a critical aspect of ancient and modern healing practices; many ancient cultures recognized the impact of environmental factors on health. For instance, Romans noted the influence of seasonal changes on diseases and human well-being. They observed that certain illnesses were more prevalent during specific times of the year, and this awareness guided their medical practices and public health policies.

Similarly, ancient Chinese medicine incorporated the understanding of environmental factors, such as wind, cold, heat, and dampness, into their diagnostic and treatment frameworks. In ancient India, the Ayurvedic system of medicine emphasized the relationship between the environment and health. Ayurveda identifies 3 fundamental bodily humors, or doshas—Vata, Pitta, and Kapha—which are believed to be influenced by climatic conditions. Seasonal routines and dietary adjustments are recommended to maintain the balance of these doshas and promote health. This holistic approach underscores the importance of aligning one’s lifestyle with environmental changes to prevent disease and enhance well-being.

Changes to the climate and environment can seriously affect people’s mental and physical health, and can compromise their physical safety, access to clean air, safe water, food and health care, resulting in vulnerability, illness, injury or death. Even small or gradual changes to the environment can expose people to increased risk.

Climate change presents a fundamental threat to human health. It affects the physical environment as well as all aspects of both natural and human systems – including social and economic conditions and the functioning of health systems. It is therefore a threat multiplier, undermining and potentially reversing decades of health progress. As climatic conditions change, more frequent and intensifying weather and climate events are observed, including storms, extreme heat, floods, droughts and wildfires. These weather and climate hazards affect health both directly and indirectly, increasing the risk of deaths, noncommunicable diseases, the emergence and spread of infectious diseases, and health emergencies. Climate change is also having an impact on health workforce and infrastructure, reducing capacity to provide universal health coverage (UHC).

Climate shocks and growing stresses such as changing temperature and precipitation patterns, drought, floods and rising sea levels degrade the environmental and social determinants of physical and mental health. All aspects of health are affected by climate change, from clean air, water and soil to food systems and livelihoods. Climate change is impacting health in a myriad of ways, including by leading to death and illness from increasingly frequent extreme weather events, such as heatwaves, storms and floods, the disruption of food systems, increases in zoonoses and food-, water- and vector-borne diseases, and mental health issues. Climate change is undermining many of the social determinants for good health, such as livelihoods, equality and access to health care and social support structures.



*Figure 19. : An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. Climate change impacts health both directly and indirectly, and is strongly mediated by environmental, social and public health determinants.*

  One of the most direct impacts of climate change on health is the increase in extreme weather events, such as heatwaves, floods, and hurricanes. These events can lead to immediate physical injuries, deaths, and long-term health problems. Heatwaves, for instance, have been associated with increased mortality and morbidity, particularly among vulnerable populations such as the elderly, children, and those with preexisting health conditions. Prolonged exposure to extreme heat can cause heat exhaustion and heatstroke and exacerbate cardiovascular and respiratory diseases. Studies have shown a significant rise in hospital admissions and emergency room visits during heatwaves, indicating the severe impact of extreme temperatures on public health.

Urban areas, known as heat islands, experience higher temperatures than rural areas due to human activities and infrastructure, further exacerbating health risks in densely populated regions.  Climate change also influences the distribution and transmission of vector-borne diseases and illnesses transmitted by mosquitoes, ticks, and fleas. Changes in temperature, humidity, and precipitation patterns can expand the geographical range of these vectors, leading to the spread of diseases like malaria, dengue fever, and Lyme disease into new regions.  For example, the increased prevalence of warmer temperatures has been linked to the expansion of the mosquito species *Aedes aegypti* and *Aedes albopictus*, which are primary vectors for dengue fever and Zika virus. This expansion poses significant public health challenges as previously unaffected populations. Climate change impacts agricultural productivity and food security, affecting nutritional health. Changes in temperature and precipitation patterns can disrupt crop yields, reduce food availability, and increase food prices. This can lead to malnutrition, particularly in low-income populations relying heavily on local agriculture for sustenance. Malnutrition can weaken the immune system, making individuals more susceptible to infectious diseases and other health problems. Climate change can affect the nutritional quality of food, as elevated carbon dioxide levels can reduce the concentration of essential nutrients in crops such as protein, zinc, and iron.

**Flooding**

Flooding, another consequence of climate change, poses multiple health risks, including injuries, drowning, and waterborne diseases. Contaminated floodwaters can spread pathogens, leading to outbreaks of diseases such as cholera, typhoid fever, and leptospirosis. The aftermath of flooding can also result in long-term mental health issues, such as anxiety, depression, and post-traumatic stress disorder, as individuals cope with the loss of homes, livelihoods, and loved ones. The displacement caused by floods often leads to overcrowded living conditions, exacerbating the spread of infectious diseases and creating additional public health challenges.

**Air quality**

Air quality is another critical aspect of the relationship between climate and health. Climate change can exacerbate air pollution, which harms respiratory and cardiovascular health. For instance, higher temperatures can increase the formation of ground-level ozone. This harmful air pollutant can cause respiratory problems and exacerbate asthma and chronic obstructive pulmonary disease.

**Wildfires,**

Wildfires, becoming more frequent and severe due to climate change, release large quantities of particulate matter and toxic gases into the air, further degrading air quality and posing significant health risks. Indigenous fire management practices, such as controlled burning, have been used for thousands of years to manage landscapes and reduce the risk of large, uncontrolled wildfires. These practices involve setting small, controlled fires to clear underbrush and promote the growth of fire-resistant plant species. By reducing the buildup of flammable materials, controlled burning can help prevent catastrophic wildfires and protect ecosystems and communities. Incorporating Indigenous fire management practices into modern land management strategies can mitigate the health risks associated with wildfires and promote healthier ecosystems.

**Mental health**

Mental health is also affected by climate change. The psychological impacts of climate change, including stress, anxiety, and depression, are increasingly recognized as important public health issues. The uncertainty and fear associated with the long-term effects of climate change can lead to eco-anxiety, a chronic fear of environmental doom. Communities that experience the direct impacts of climate change, such as natural disasters, often face long-term mental health challenges as they deal with the trauma and loss associated with these events. The mental health impacts of climate change highlight the need for comprehensive public health strategies that address physical and psychological well-being.  Indigenous communities are particularly vulnerable to the health impacts of climate change due to their close relationship with the environment and reliance on natural resources for their livelihoods and cultural practices.

Climate change threatens traditional ways of life, including hunting, fishing, and agriculture, which can lead to food insecurity and loss of cultural heritage. Many Indigenous communities are located in areas highly susceptible to climate change impacts, such as coastal regions and arctic zones. The displacement and environmental degradation caused by climate change can have profound effects on the physical, mental, and cultural health of Indigenous peoples.

Indigenous communities offer valuable insights into sustainable land management and climate adaptation practices. The knowledge, practices, and beliefs that Indigenous peoples have developed over generations through their close interaction with the environment includes understanding local ecosystems, seasonal patterns, and sustainable resource management techniques.

**Water management**

Indigenous communities have developed sophisticated water management systems that ensure the sustainable use and conservation of water resources including techniques for capturing and storing rainwater, managing irrigation, and protecting water sources from contamination. Integrating these traditional practices with modern water management approaches can enhance water security and improve health outcomes by ensuring access to clean and reliable water sources. (121)

**Shamanısm**

Shamanism, a term derived from the Tungus people of Siberia, encompasses diverse spiritual and healing practices in cultures worldwide. Shamanism is one of the oldest forms of human spirituality and healing in prehistoric times, predating organized religions and formal medical systems. At its core, shamanism revolves around the belief in the existence of a spiritual realm inhabited by guiding forces, ancestors, and supernatural beings, with shamans serving as intermediaries between the human and spirit worlds. The origins of shamanic practices have emerged as early as the Upper Paleolithic period, over 30,000 years ago. Cave paintings, rock art, and artifacts found in regions such as Europe, Asia, Africa, and the Americas provide tantalizing glimpses into the spiritual beliefs and practices of ancient hunter-gatherer societies, many of which bear striking similarities to modern shamanic traditions. The figure of the shaman is central to shamanism, an individual believed to possess special powers of healing, divination, and communication with the spirit World . Shamans undergo rigorous training and initiation rites, often involving periods of solitude, fasting, and visionary experiences induced through the use of psychoactive plants or techniques such as drumming, chanting, or dance . Shamans enter altered states of consciousness through these practices, enabling them to journey into the spirit world to seek guidance, retrieve lost souls, or perform healing rituals . The role of the shaman varies widely across cultures, reflecting the diverse beliefs and practices of different indigenous societies.

In some cultures, such as the Inuit of the Arctic or the Aboriginal peoples of Australia, shamans play a central role in hunting, healing, and maintaining harmony with the natural World . Among the indigenous tribes of the Amazon rainforest, shamans known as ayahuasqueros administer ayahuasca, a powerful psychedelic brew, as a sacrament for spiritual insight and healing . In Siberia and Central Asia, shamanic traditions persist among the Tungus, Yakut, and Mongolian peoples, where shamans known as “tengeri” or “böö” continue to practice their ancient rites.

 Shamanic healing encompasses various techniques to restore balance and harmony to the individual and the community. Central to shamanic healing is the concept of soul loss, believed to occur when a person experiences trauma, illness, or spiritual disconnection. Shamans diagnose and treat soul loss through rituals such as soul retrieval, in which lost fragments of the soul are recalled and reintegrated, or spirit extraction, in which harmful energies or entities are removed from the body. In addition to soul healing, shamans often employ herbal medicine, ritual purification, and symbolic acts to promote physical, emotional, and spiritual well-being.

Sacred plants such as tobacco, peyote, and ayahuasca are used in shamanic ceremonies for their healing properties and ability to induce altered states of consciousness conducive to spiritual insight and transformation. Rituals such as sweat lodges, vision quests, and sacred dances are powerful means of communing with the spirit world and accessing hidden realms of knowledge and wisdom . The evolution of ancient healing practices from shamanism to Hippocratic medicine has left a profound legacy that continues to influence modern interpretations of health and wellness. Throughout history, various cultures have developed intricate systems of healing that blend empirical observations with spiritual beliefs, resulting in holistic approaches to well-being. These ancient practices are being rediscovered, reinterpreted, and integrated into contemporary healthcare, offering new insights into the nature of healing.

Shamanism, one of the oldest known healing traditions, dates back thousands of years and is still practiced in many indigenous cultures worldwide. Shamans serve as intermediaries between the spiritual and physical realms, using rituals, ceremonies, and plant medicines to treat illness and restore balance to the individual and the community. While shamanic practices vary widely across cultures, they share common themes of interconnectedness, reverence for nature, and the belief in the healing power of the spirit.

The legacy of shamanism can be seen in modern interpretations of healing, such as energy medicine, holistic therapies, and mind-body practices. These approaches recognize the interconnectedness of mind, body, and spirit and seek to address the root causes of illness rather than just the symptoms. Techniques like acupuncture, reiki, and meditation draw inspiration from shamanic principles, tapping into the body’s innate ability to heal itself and promoting overall well-being. (122-123)

People seek alternatives to conventional pharmaceuticals and invasive procedures and turn to ancient healing traditions for inspiration and guidance. Herbs like echinacea, ginseng, and chamomile, once used by ancient Egyptian healers, are now widely recognized for their medicinal properties and incorporated into modern healthcare practices.

The teachings of Hippocrates, laid the foundation for modern Western medicine. Hippocratic medicine emphasizes the importance of observation, diagnosis, and treatment based on natural principles rather than supernatural beliefs. The Hippocratic Oath, which outlines ethical guidelines for medical practice, remains a cornerstone of medical ethics today. The legacy of Hippocratic medicine can be seen in the scientific approach to healthcare and the emphasis on evidence-based medicine. (124).

While modern medicine has made significant advancements in diagnosis and treatment, it has also led to a reductionist view of health, focusing primarily on the physical aspects of illness and neglecting the interconnectedness of mind, body, and spirit. There is a growing recognition of the limitations of this approach and a renewed interest in holistic and integrative approaches to healthcare. Cultural contexts and belief systems significantly shape the understanding and practice of healing traditions across different societies. Throughout history, diverse cultures have developed unique approaches to health and wellness that reflect their beliefs, values, and social structures. These cultural contexts influence the types of treatments and remedies used and the underlying philosophies and perceptions of health and illness.

In many indigenous cultures, healing is deeply intertwined with spirituality and communal practices. Shamans, or traditional healers, mediate between the physical and spiritual worlds, using rituals, ceremonies, and plant medicines to address illness and restore balance to the individual and the community. For example, among the Indigenous peoples of North America, healing rituals often involve drumming, chanting, and purification ceremonies aimed at harmonizing the mind, body, and spirit. These practices are rooted in a worldview that emphasizes the interconnectedness of all living beings and the importance of maintaining harmony with the natural world.

Modern Western medicine is primarily based on a biomedical model that focuses on the physical aspects of illness and relies on empirical evidence and scientific research to guide diagnosis and treatment. While this approach has led to significant advancements in medical technology and treatment modalities, it has also been criticized for its reductionist view of health and its neglect of the psychosocial and spiritual dimensions of illness.

There is a growing recognition within the medical community of the importance of cultural competency and the need to consider patients’ cultural beliefs and practices when providing care. Cultural contexts and belief systems influence how illness and healing are understood and experienced within communities. In many non-Western cultures, illness is seen as a social or spiritual imbalance rather than a physiological malfunction. Healing is a communal affair involving family members, community leaders, and traditional healers who come together to support the individual in their journey toward wellness. Traditional healing ceremonies and rituals serve not only to treat physical symptoms but also to address underlying social, emotional, and spiritual issues that may be contributing to the illness. Medical techniques and therapies encompass various practices in diagnosing, treating, and preventing illness and disease. Throughout history, diverse cultures have developed unique approaches to healthcare, drawing on a combination of empirical observations, cultural traditions, and philosophical beliefs. From ancient healing rituals to modern medical innovations, these techniques and therapies reflect the evolution of human understanding and the ongoing quest for improved health and well-being.

In ancient times, healing practices were often intertwined with spiritual beliefs and rituals. Shamans, or traditional healers, served as intermediaries between the physical and spiritual worlds, using ceremonies, herbs, and incantations to treat illness and restore balance to the individual and the community. Ancient Egyptian medicine incorporated spiritual rituals alongside practical treatments such as herbal remedies and surgical procedures, reflecting a holistic approach to health that emphasized the interconnectedness of mind, body, and spirit.

Hippocratic medicine, emphasized the importance of observation, diagnosis, and treatment based on natural principles rather than supernatural beliefs. The Hippocratic Oath, which outlines ethical guidelines for medical practice, remains a cornerstone of medical ethics. Advancements in anatomy, physiology, and pharmacology, have paved the way for evidence-based medicine and clinical research.

In Taoist philosophy, TCM views health as a balance between yin and yang, 2 opposing forces representing different aspects of the natural world. Illness is seen as a disruption of this balance, and treatments aim to restore harmony within the body and with the external environment. Acupuncture, herbal medicine, and qigong are commonly used therapies in TCM, each based on energy flow (qi) principles and the interconnectedness of the body’s systems.

Ayurveda, the traditional medicine of India, is similarly based on a holistic understanding of health and wellness. In Ayurveda, health is viewed as a dynamic equilibrium between the 3 doshas, or bodily energies: vata, pitta, and kapha. Each person has a unique constitution, or Prakriti, determining their susceptibility to illness and optimal healing path. Ayurvedic treatments include dietary recommendations, herbal remedies, massage, and meditation, all aimed at restoring balance within the body and promoting overall well-being.  In recent years, there has been a growing interest in complementary and alternative therapies as people seek alternatives to conventional medical treatments. Practices such as acupuncture, chiropractic care, and naturopathy are gaining popularity as patients look for holistic approaches to health that address the root causes of illness rather than just the symptoms. Integrative medicine, combining conventional biomedical treatments with complementary therapies, is increasingly embraced by healthcare providers and patients, offering a more comprehensive and personalized approach to healthcare.

The transmission of knowledge and exchanging ideas have been crucial in developing and disseminating medical practices throughout history. From ancient to modern times, societies have shared and adapted healing techniques, theories, and technologies. This knowledge exchange process has been facilitated by trade, migration, conquest, and the spread of religious and philosophical beliefs, each contributing to the cross-cultural fertilization of medical knowledge and practices.

One of the earliest examples of knowledge transmission occurred during the ancient Silk Road trade routes, which connected East and West and facilitated the exchange of goods, ideas, and technologies between civilizations. Along these trade routes, merchants, travelers, and scholars exchanged silk, spices, precious metals, medical knowledge, herbal remedies, and healing practices. Chinese medicine, emphasizing acupuncture, herbal medicine, and qigong, spread westward along the Silk Road, influencing medical practices in Central Asia, the Middle East, and Europe.

Similarly, Indian Ayurvedic medicine found its way to neighboring regions through trade and cultural exchange, leaving a lasting imprint on the medical traditions of Southeast Asia and beyond. The transmission of medical knowledge was not limited to trade routes but also occurred through the movement of people and the spread of religious and philosophical ideas. For example, the spread of Buddhism from India to East Asia facilitated the exchange of medical knowledge between Indian and Chinese cultures, leading to the integration of Ayurvedic principles into TCM. Buddhist monks, who traveled along trade routes and established monasteries and temples in distant lands, served as conduits for transmitting medical texts, herbal remedies, and healing practices, fostering a cross-cultural exchange of ideas that enriched Indian and Chinese medical traditions.

The Islamic Golden Age flourished from the 8th to the 14th centuries and saw the translation of ancient Greek, Roman, Indian, and Persian medical texts into Arabic, preserving and disseminating medical knowledge across the Islamic world. Muslim scholars, known as the “Golden Chain of Science,” translated works by Hippocrates, Galen, Aristotle, and other ancient thinkers into Arabic, preserving and expanding upon their ideas and discoveries.

These translated texts and original contributions by Islamic scholars formed the foundation of medical education and practice in the Islamic world and later influenced European medicine during the Renaissance. During the Renaissance, Europe experienced a revival of interest in classical learning and a resurgence of scientific inquiry. This led to rediscovering and translating ancient medical texts from Greek, Latin, and Arabic sources. This rediscovery of ancient wisdom and discoveries in anatomy, physiology, and pharmacology laid the groundwork for modern Western medicine.

The printing press, in the 15th century, further facilitated the dissemination of medical knowledge by making books and journals more widely available, enabling physicians and scholars to share ideas and discoveries across geographic boundaries. In the modern era, the exchange of medical knowledge has been accelerated by advances in communication and transportation, as well as by international collaborations and scientific networks.

Medical journals, conferences, and online platforms allow researchers and clinicians worldwide to share their findings, discuss best practices, and collaborate on research projects. International organizations such as the World Health Organization and the United Nations Educational, Scientific and Cultural Organization promote global cooperation in health research, education, and policy, facilitating the exchange of medical knowledge and expertise among countries. Archaeological and anthropological evidence provides valuable insights into the history of medical practices and the evolution of healthcare systems throughout human history. Researchers can uncover clues about past societies’ health, healing techniques, and cultural beliefs by studying ancient artifacts, human remains, and written records. This interdisciplinary approach helps us understand how medical knowledge was acquired, transmitted, and applied in different cultural contexts, shedding light on how humans have sought to understand and manage illness and disease. One of the primary sources of archaeological evidence for ancient medical practices is human skeletal remains. Analysis of skeletal remains can reveal information about the prevalence of disease, patterns of injury, and surgical techniques used by ancient peoples. For example, evidence of trepanation, the surgical procedure of drilling holes in the skull, has been found in archaeological sites dating back thousands of years, suggesting that ancient cultures practiced this technique for therapeutic purposes, such as relieving headaches or treating head injuries.

Evidence of fractures, infections, and other skeletal abnormalities can provide insights into the types of injuries and illnesses that affected ancient populations and the methods used to treat them. Ancient medical artifacts, such as surgical instruments, pharmaceutical containers, and medical texts, also offer valuable clues about the practice of medicine in antiquity. For example, the discovery of the Edwin Smith Surgical Papyrus, an ancient Egyptian medical text dating back to around 1600 BCE, provides detailed instructions for diagnosing and treating various injuries and illnesses, including fractures, wounds, and infections. Archaeological excavations of ancient Roman sites have uncovered surgical instruments, such as scalpels, forceps, and probes, as well as evidence of medical facilities, such as hospitals and healing temples, indicating a sophisticated understanding of surgical techniques and healthcare delivery in the ancient world.

In addition to physical artifacts, written records and inscriptions offer valuable insights into ancient healers’ and physicians’ beliefs and practices. For example, the writings of Hippocrates, often called the “Father of Western Medicine,” provide detailed descriptions of medical conditions, diagnostic methods, and treatment options used by ancient physicians. (125)

Similarly, ancient Indian texts, such as the Charaka Samhita and the Sushruta Samhita, contain detailed descriptions of Ayurvedic medical practices, including herbal remedies, surgical techniques, and dietary recommendations. These texts provide valuable information about ancient medical practices and offer insights into the cultural and philosophical beliefs that shaped them. Anthropological studies of contemporary indigenous cultures also offer useful insights into traditional healing practices and the cultural beliefs that underpin them. For example, studies of traditional healing practices among indigenous peoples in the Americas have revealed that they use herbal medicines, spiritual rituals, and ceremonies to treat illness and promote well-being. Similarly, studies of traditional healing practices in Africa, Asia, and Oceania have documented using plants, minerals, and animal products for medicinal purposes and the role of shamans, medicine men, and other healers in diagnosing and treating illness. These studies highlight the importance of cultural context in shaping the practice of medicine and the role of traditional healers as custodians of indigenous knowledge and wisdom. (126)

The influence of ancient healing practices on modern medicine is profound and far-reaching, shaping how we understand, diagnose, and treat illness and disease. Throughout history, cultures worldwide have developed sophisticated systems of healing based on empirical observations, cultural traditions, and spiritual beliefs. While modern medicine has made significant advancements in technology and treatment modalities, it continues to draw inspiration from ancient healing traditions, integrating their wisdom and practices into contemporary healthcare. One of the key ways ancient healing practices have influenced modern medicine is through their emphasis on holistic approaches to health and wellness.

Ancient healing traditions such as Ayurveda, TCM, and indigenous healing practices recognize the interconnectedness of mind, body, and spirit and seek to address the root causes of illness rather than just the symptoms. Modern healthcare providers increasingly embrace this holistic perspective and recognize the importance of treating the whole person rather than just the disease. Ayurveda, the traditional medicine of India, emphasizes the importance of balance and harmony within the body and with the natural environment. Ayurvedic treatments, which include dietary recommendations, herbal remedies, massage, and meditation, aim to restore balance within the body and promote overall well-being.In recent years, there has been growing interest in Ayurvedic principles among Western healthcare providers, who recognize the value of personalized, holistic approaches to health and wellness. TCM views health as a balance between yin and yang, 2 opposing forces representing different aspects of the natural world. TCM treatments, such as acupuncture, herbal medicine, and qigong, aim to restore harmony within the body and with the external environment. Acupuncture, in particular, has gained widespread acceptance in Western medicine as an effective treatment for a variety of conditions, including chronic pain, anxiety, and nausea.  Another way in which ancient healing practices have influenced modern medicine is through their emphasis on preventive healthcare and lifestyle interventions.

Many ancient healing traditions advocate for healthy living practices, such as proper nutrition, regular exercise, stress management, and mind-body techniques, to maintain health and prevent illness. These principles are increasingly being incorporated into modern healthcare practices as healthcare providers recognize the importance of addressing underlying lifestyle factors in preventing and managing chronic diseases. For example, mindfulness-based stress reduction, a program developed by Jon Kabat-Zinn based on Buddhist mindfulness practices, has been shown to reduce stress, anxiety, and depression and improve overall well-being.

Mindfulness-based stress reduction is now being used in healthcare settings around the world as an adjunctive therapy for various medical conditions, including chronic pain, cardiovascular disease, and cancer. In addition to holistic approaches and preventive healthcare, ancient healing practices have influenced modern medicine by discovering and developing pharmacological agents derived from natural sources. The very fact that an increasing number of studies on mindfulness and its clinical applications are being funded and published and that an increasing number of doctoral theses on mindfulness are appearing in Dissertation Abstracts suggests that this is an area that is currently sparking considerable interest, perhaps driven primarily by the intuition that new dimensions of therapeutic benefit and novel insights into mind/body interactions might accrue through its exploration. Increase of interest in mindfulness and its applications to specific affective conditions has provoked within the cognitive therapy community the development of mindfulness-based cognitive therapy and the use of mindfulness within dilectical behavior therapy (DBT).

Professionals coming to the field with professional interest and enthusiasm recognize the characteristics of mindfulness as a meditative practice not simply seized upon as the next promising cognitive behavioral technique or exercise, but decontextualized, and “plugged” into a behaviorist paradigm with the aim of driving desirable change, or of fixing what is broken.Mindfulness is the fundamental attentional stance underlying all streams of Buddhist meditative practice: the Theravada tradition of the countries of Southeast Asia (Thailand, Burma, Cambodia, and Vietnam); the Mahayana (Zen) schools of Vietnam, China, Japan, and Korea; and the Vajrayana tradition of Tibetan Buddhism found in Tibet itself, Mongolia, Nepal, Bhutan, Ladakh, and now large parts of India in the Tibetan community in exile. These traditions all have various schools, subtraditions, and particular texts that they revere more than others, so the actual practices and emphases regarding mindfulness can vary considerably, even within one tradition, such as Theravada or Zen .

Nevertheless, mindfulness, as elucidated by the Buddha in two discourses, the Anapanasati Sutra and the Satipathana Sutra , is the core teaching and constitutes the foundation upon which all of these various forms and traditions rest. In these traditions the actual practice of mindfulness is, however, always nested within a larger conceptual and practice-based ethical framework oriented towards nonharming (an orientation it shares with the Hippocratic tradition of Western medicine). This “view” includes a skillful understanding of how unexamined behaviors and what Buddhists would call an untrained mind can significantly contribute directly to human suffering, one’s own and that of others. It also includes the potential transmutation of that suffering through meditative practices that calm and clarify the mind, open the heart, and refine attention and action.

Over the past 40 years or so all of these Buddhist traditions have taken root in the West to one degreeor another and have by this time been taken up by several generations of Westerners, who practice these methods in their own lives on a daily basis as well as through participation in periodic teacher-led, intensive meditation retreats, which can last from a weekend to 3 months or more . This phenomenon represents a cultural shift that may be only in its infancy. It provides a range of rich resources for personal practice and dialogue that can contribute toward the training and development of a cohort of highly competent teachers, from a wide variety of professional backgrounds, committed to the effective delivery of authentic mindfulness-based interventions in various settings.

Mindfulness is often spoken of synonymously as “insight” meditation, which means a deep, penetrative nonconceptual seeing into the nature of mind and world. This seeing requires a spirit of perpetual and persistent inquiry—as in, “What is this?”—toward whatever arises in awareness, and toward “who is attending,” “who is seeing,” “who is meditating.” Its role in deep inquiry and the cultivation of insight have led some to argue that that mindfulness provides a unique perspective that can inform critical issues in cognitive science, neurophenomenology, and attempts to understand the cognitive underpinnings of the nature of human experience itself . From the perspective of the behavioral sciences, mindfulness can be thought of as a “consciousness discipline,” that explicates the generic paradigm of the meditative traditions and their associated disciplines and shows how such disciplines might be approached empirically by the behavioral sciences without falling into paradigm clash or a range of category errors, which can unwittingly ignore or dismiss the deepest and most subtle features of such practices, thereby predisposing investigators to draw erroneous conclusions.

In encountering the consciousness disciplines and the question of their possible adaptation and application in secular clinical or medical contexts, it is critically important to treat mindfulness and the traditions that have articulated it much as a respectful anthropologist would treat an encounter with an indigenous culture or a different epistemology . This intimate sensitivity will be necessary to understand, evaluate, and preserve essential elements of the universal dharma dimension of mindfulness practice as it is analyzed by and incorporated into Western science. In the crosscultural context of scientific studies of Tibetan monks practicing meditation, sensitivity to differences in orientation and motivation between neuroscientists and meditators around both the meditation practices and the set and setting in which they are investigated is essential for the investigation to have integrity and to be interpretable and valid from the perspective of both the scientists and the meditators .

In a “cross-cultural” development of note, EEG, fMRI, and PET studies of brain activity in the evocation of specific meditative states and positive feelings, such as compassion and devotion, in a highly trained long-term monastic practitioner. These investigations show a range of stable patterns of brain activity (“neural signatures of different mental states”) that have never been observed in naive subjects, patterns that can be replicated by the subject at will, depending on his choice of meditative practice. Such studies have multiple implications for research in affective neuroscience and neuroplasticity . The “performance” is always this moment unfolding . This engagement takes a variety of forms, from a range of formal practices that are undertaken for varying periods of time on a regular basis, to informal practices that are aimed at cultivating a continuity of awareness in all activities of daily living. In fact, the term “practice” used in this way is better understood as a way of being, a way of seeing, which is embodied, inhabited, grown into through the implementation of the methods and techniques that comprise the discipline . it is an invitation to allow oneself to be where one already is and to know the inner and outer landscape of the direct experience in each moment. (127)

**Buddhism**

Buddhism is one of the oldest traditions in the world, founded in India by Gautama Buddha more than 2500 years ago. Its origin and spread began on the Indian subcontinent, and a few decades later, it

spread to Southeast Asian countries and other parts of the world. Buddhism has historically transformed into religion and attracted the masses of followers around the world. It has preached the message of non-violence and peace and introduced the idea of humanism to the world. Buddhism is a tradition that focuses on the individual spiritual development of human beings and a philosophy that teaches us to focus on humanistic ways of life in the world and motivate humans to lead ethical lives. The teachings of Buddhism are recorded in different collections of scriptures known as ‘Canons.’

During the Buddha period, it was derived from oral tradition and preserved through communal chanting. In this way, the ‘Pali Canon’ is one of the most essential to be written in Pali in Sri Lanka in the 1st century BC. The scripture consists of three Pitaka or baskets: Sutta-Pitaka (Buddha’s sermons), Vinaya-Pitaka (Monastic rules), and the Abhidhamma-Pitaka (Scholastic works). These three basic aspects of Buddhism have positively affected human beings. The principal teachings of Buddhism are composed in the ‘Four Noble Truths and the Noble Eightfold Paths.’ It is based on Buddhism’s moral, meditative, and spiritual lives. The purpose of Buddhist meditation is to attain Nibbana. “Nibbana is the cessation of mentality and materiality” .

HILOSOPHY OF BUDDHISM AND VIPASSANA MEDITATION

Buddhism differs from many other faiths and traditions in the world. In this philosophy, different schools of thought have been established. Therefore, every school assembled its own ‘Canons’ in

different languages. However, the ‘Pali Canon’ remained authoritative for the Theravada Buddhist School. It does not run on the relationship between humans and God. It does not believe in God, the

personal creator. In a sense, Buddhism is more than religion. Therefore, in Buddhism, human beings are aware of their thoughts and actions, developing wisdom, compassion, and understanding.

Mahayana Buddhist meditation includes several schools of practice. These schools of Mahayana Buddhism established themselves by focusing on various Buddhist sutras, philosophical texts, and commentaries. These schools also have their own meditation techniques to achieve enlightenment. Buddhist meditation in Vajrayana is called the mandala that are meditated on in the mind. These artistic circular patterns are used to awaken the practitioner's mind to a deeper, more spiritual nature

There are different styles of Buddhism, including Mahayana, Vajrayana, Zen, and Theravada Buddhism. Meditation plays the most important role to understand the actual problem of human beings.

Buddhism’s heartless experimental approach to the deep sense of being might be the motivation that

Albert Einstein said, “The religion of the future will be a cosmic religion. It should transcend a personal God and avoid dogma and theology. Covering both the natural and spiritual, it should be based on a religious sense arising from the experience of all things, natural and spiritual, as a meaningful unity. If there is any religion that would cope with modern scientific needs, it would be Buddhism.

In Buddhism, people feel confident that they can improve their consciousness and understand themselves. It means focusing on their enormous energy (of their understanding) through prayer for meditation to develop their relationship eventually in life by examining the ‘Noble Eightfold Path,’ the Buddha, is called the supreme physician. The ‘Noble Eightfold Path’ summarized ahead

three fundamental zones for Buddhist profound practice, that composed of Prajna or Wisdom; Sila, or ‘Moral Virtue’ for example, the ‘Five Precepts’; and Samadhi, or ‘Mental Concentration,’ for example,

such as reflection and care.

The cause of sorrow in Buddhism is said to be desire and ignorance, which are the roots of sorrow. By desire. Buddhists refer to longing for pleasure, material goods, and immortality, all of which are

desires that can never be satisfied . The reason is craving, the unquenchable power of indulgence, and existence, which keeps the wheel of rebirth in constant motion. The end of suffering is the reversal of this genetic connection and the destruction of ‘craving (Trishna). This is a way of stopping the victim from the middle path of moral and intellectual schooling, which escapes all extremes through conduct and attitude. Right View is a ‘Noble Eight Fold Path’ created from Right Right View, Resolution, Right Speech, Right Action, Right Livelihood, Right Effort, Right Mindfulness, and Right

Concentration so that the concentration of the mind and continuity of the body can be attained from the mental state. Meditation practice removes anger, grief, painful sensations, stiffness, detachment, and so forth.

Vipassana meditation, discovered by Buddha approximately 2500 years ago, is one of the oldest meditation techniques in India. This meditation technique is a non-denominational scientific technique of self-transformation through self-observation in society. Vipassana meditation is a moral and social path that sees and develops humans from within nature through the outline of their mind and body.

VARIOUS TYPES OF BENEFITS FROM VIPASSANA

MEDITATION

Stress reduction and relaxatioOne of the most important benefits of Vipassana meditation is its ability to reduce stress and promote relaxation. By focusing on breathing and physical sensations, practitioners can shift their attention away from stress-causing thoughts and experiences. This process helps activate the body’s relaxation response, which leads to a decrease in the production of stress hormones such as cortisol and an increase in the release of feel-good neurotransmitters such as endorphins .

Improving the functioning of the immune system

Vipassana meditation can improve physical well-being by increasing the body’s ability to ward off infection and maintain overall health. The regular practice of Vipassana meditation has been linked

to improved immune system functioning, reducing stress and promoting relaxation contributes to a more robust immune system, as chronic stress is known to weaken the immune response.

Decreased blood pressure and heart rate

Vipassana meditation helps lower blood pressure and heart rate in both healthy individuals and those with pre-existing cardiac problems. Its use can reduce the risk of high blood pressure and other cardiovascular problems. Additionally, Vipassana meditation can help lower heart rate, thereby contributing to a more relaxed and calm state. Poor sleep quality is often associated with stress, anxiety, and an overactive mind. Vipassana meditation may help improve sleep quality by promoting relaxation and reducing stress, allowing practitioners to experience deeper and more restorative sleep.

Vipassana meditation helps to cultivate greater self-awareness by encouraging practitioners to observe their thoughts, feelings, and bodily sensations without judgment. This increased sense of self-

awareness can lead to increased emotional intelligence, allowing individuals to better understand their emotional reactions and empathize with the feelings of others. As a result, exercisers develop stronger interpersonal relationships and more effective communication skills. Regular practice of Vipassana meditation can improve focus, mental clarity, and overall cognitive function. By training the mind to focus on breath and physical sensations, practitioners can develop the ability to maintain sustained attention and filter out distractions more effectively. This increased focus can be applied to daily life, improving productivity and problem-solving skills.

Increased in the quality of sleep

Increased self-awareness and emotional intelligence

Improved focus, clarity, and cognitive function

Reduction in anxiety, depression, and other mental health problems

Vipassana meditation can effectively reduce the symptoms of anxiety, depression, and other mental health problems,negative thoughts and emotional distress and contribute to a better sense of inner

Cultivating inner peace, happiness, and overall well-being

peace, happiness, and overall well-being by fostering a deeper understanding of the impermanent nature of self and reality. As practitioners develop self-awareness, emotional intelligence, and

resilience, they often experience a greater sense of satisfaction. The Vipassana meditation technique is an important component of Buddhism to develop human liberation through the practice of ethics (Sila), meditation (Samadhi), and perception (Panna). By practicing this meditation method, people can detect the wildness of their body, speech, and mind. It is not only a practice to be performed in the special environment of a meditation retreat, rather a home remedy that can provide happiness and harmony as a way of life. It is a path through moral commitment, lifetime meditative discipline, self-knowledge, and self-observation.

Anapana is a fundamental Vipassana meditation technique that focuses on human breath, as it naturally flows in and out of the body. By observing the sensations of breath, such as the sensation of air passing through the nostrils or the rise and fall of the abdomen, practitioners can develop greater concentration and awareness and calm the mind,and allowing to better observe one's thoughts and feelings without becoming entangled. Body scanning, which is a systematic observation of bodily sensations, is an important technique in Vipassana meditation. The purpose of body scanning is to cultivate awareness of the ever-changing feelings of the body and develop a deeper understanding of the impermanent nature of all phenomena. From the top of the head and moving down to the toes, the practitioner pays close attention to any physical sensations they experience such as tingling, heat, pressure, or pain. By regularly practicing body scanning, individuals can gain greater insight into the interconnectedness of the mind and body, leading to increased self-awareness.

Metta Bhavana (Developing loving-kindness)

Metta Bhavana, a complementary practice to Vipassana, focuses on developing love, compassion, and goodwill toward self and others to help practitioners develop a balanced and compassionate attitude toward their inner experiences.One of the key scientific concepts underlying the benefits of Vipassana meditation is neuroplasticity, which is the ability of the brain to change and adapt throughout a person's lifetime. Through consistent meditation, individuals can effectively “re-wire” their brain, creating new neural connections and pathways that support enhanced cognitive function, emotional regulation, and overall mental well-being. This process of neuroplasticity allows permanent changes in the structure and function of the brain.

Effects of Vipassana Meditation on the Structure and Function of

the Brain

Key findings include the following:

Increased in grey matter density in various areas of the brain, such as the hippocampus

(involved in learning and memory) and prefrontal cortex (involved in executive functions such as decision-making and self-control)

Improved connectivity between brain regions

improved connectivity between different brain regions, supporting enhanced cognitive

function and emotional regulation

Low activity in the Defaulting Mode Network (DMN) , which is a network of brain regions that is activated when the mind wanders and engages in self-referential thinking. Vipassana meditation has been shown to reduce activity in the DMN, thereby reducing mind-wandering and improving focus

reducing stress and improving mental health. Mindfulness, a cornerstone of Vipassana meditation, is important for reducing stress and improving mental health. By developing a non-judgmental awareness of their thoughts, feelings, and physical sensations, individuals can learn to observe their inner experiences without becoming overwhelmed or reactive.

This mindful approach allows practitioners to manage stress and emotional challenges better, thereby improving mental health and well-being and to iminish mental suffering, via investigation of mind/body. Developing resilience against stress, by the connected threefold training discipline → concentration → insight.

1 Discipline: following the exercises at three levels.

1. Exterior discipline: doing exercises with dignified posture, being on time.

2. Interior discipline. an interior dignified attitude.

3. Perseverance: not giving up when there is resistance or when one feels sick.

Ethical discipline: five rules of respect for the following.

1. life (no killing/harming living beings, including oneself);

2. possessions (no stealing, or taking that what has not been given);

3. speech (before speaking ask yourself: is it true? is it necessary? can it be hurting/harmful?);

4. intimate relationships (only with mutual consent and within agreement of your living situation);

5. body (no drugs, alcohol, tobacco; coffee is allowed).

2. Concentration. One checks sensory input: Seeing, hearing, and sensing (touch). Attention to the other two physical senses, tasting and smelling, are not used during sitting meditation. Input from one of the senses is called an object. Attention ( Being aware), one usually notices that attention changes within a single sense from one object to another, and also from objects in one sense to those in another. Effortless attention moves around. The function of attention in homo sapiens and other animals is to act like a radar, to be on the alert if a danger or opportunity occurs. It can be observed that this attention can be directed by the will, or by the intention. One can do this within one sense on various objects. And then change and do the same within another sense. Finally one can check that hopping from one object in one sense to another one in another sense is something that one does all the time. Then one chooses the meditation object. It is the input on which one exercises concentration, by remaining with that object. To help the full attention one looks at qualities of the breath.

Is it long or short?

Is it smooth or undulating (like after crying)?

Is it ample or restricted?

There is also walking meditation. One stands, straight and dignified. As preparation one observes the bodily sensations: temperature warm—cold; touch: hard—soft; movements: air along cheeks, circulation.

Five Hindrances 1. desire; 2. aversion; 3. restlessness; 4. sleepiness; 5. doubt.

The five hindrances have five antidotes :

1. moderation (against desire);

2. friendliness (against aversion);

3. relaxation (against restlessness);

4. wakefulness (against sleepiness);

5. curiosity (against doubt).

Metta is another important way to counter hindrances,and develop metta ‘loving kindness’ or ‘sincere friendliness’.

Five Helpers

1. Confidence (not dogmatism);

2. Effort, energy (in balance with concentration);

3. Mindfulness (light, friendly);

4. Concentration (without attachment);

5. Knowledge, wisdom (not intellectual)

There is body, with its five physical senses” hearing, seeing, touching, smelling, tasting. Then there is the rest, considered as part of mind: feeling (pleasant, neutral, unpleasant), cognition (thought slice, image), volition (intention to do something), and consciousness/mind-state. Together these form the five groups (skandhas) , from which the world of awareness is built up. (128)

**Existential therapy (ET)**

Existential therapy (ET) is a form of psychological and existence therapy that links a clinical approach with a philosophical reading of reality. Compared to other psychotherapeutic approaches, ET’s identity is not anchored to etiological certainties or codified treatment techniques. Unlike other therapeutic approaches, ET, due its flexibility, is in constant and continuous development. By following different lines of thought related to different schools, it is open to integration with therapies that have other frames of reference and other clinical approaches, and, does not recognize irreconcilable conflicts between the different frameworks that have developed around the world.

ET refers to the complex philosophical panorama from which a new anthropology and psychopathology was generated in the 20th century that helped to overcome the stigmatization of mental illness and constituted an essential reference for the epistemology of many other psychotherapies based on different theoretical models. The existential therapist must foster a dialogue with the other that can stimulate a search for alternatives by using focusing processes, encouraging reality testing, the process of “cognitivization” , and stimulating the individual’s creativity, his lateral thinking. The dialogical process thus brings the individual directly face to face with his own “value-scope-meaning” system and with the ongoing developments that constantly change the system itself. The learning process is stimulated by the search for solutions involving both the logical (deductive) conceptual paths of vertical thinking and the creative (intuitive) paths of lateral thinking. A great help is given by the use of effective communication strategies related to subliminal logodynamics and its domains. The output of ET is always open (129)

Many of the drugs used in modern medicine originate from plants, minerals, and other natural substances used by ancient healers for medicinal purposes. For example, aspirin, one of the most widely used drugs in the world, is derived from the bark of the willow tree, which has been used for centuries as a remedy for pain and fever as well as reserpine, an antipsychotic and antihypertensive drug from Rauwolfia spp.; and antimalarials such as quinine from Cinchona bark. Many chemotherapy drugs used to treat cancer are derived from plants and other natural sources. The chemotherapy drugs paclitaxel, used to treat breast, ovarian, and lung cancers, is naturally occurring diterpenoid compound extracted from the Pacific yew tree , camptothecin, derived from the Chinese “happy tree” Camptotheca acuminata and used to prepare irinotecan and topotecan; and combretastatin, derived from the South African bush willow. By studying traditional healing practices and the medicinal properties of plants, scientists have been able to identify and develop new drugs with therapeutic potential, expanding the pharmacopeia of modern medicine. (130-134)

Modern healthcare, as societies seek to integrate traditional wisdom with contemporary medical practices. While ancient healing traditions offer valuable insights into holistic approaches to health and wellness, they also face obstacles in adapting to the complexities of modern healthcare systems. By addressing these challenges and embracing the opportunities for collaboration and innovation, we can harness the potential of ancient healing traditions to improve health outcomes and promote well-being in diverse communities. One of the primary challenges in revitalizing ancient healing traditions is the need for more scientific evidence to support their efficacy and safety. Many traditional healing practices are based on empirical observations, cultural traditions, and spiritual beliefs rather than rigorous scientific research. While some traditional therapies, such as acupuncture and herbal medicine, have been studied extensively and shown to have therapeutic benefits, others lack empirical evidence and may carry risks of harm if misused.

To integrate ancient healing traditions into modern healthcare, it is essential to conduct rigorous research to evaluate their effectiveness, safety, and mechanisms of action.Another challenge is the cultural and linguistic barriers that may hinder the transmission and preservation of ancient healing knowledge. Many traditional healing practices are passed down orally from generation to generation within specific cultural and linguistic communities, making them vulnerable to loss and erosion over time. As indigenous languages and cultural practices are threatened by globalization and urbanization, there is a risk that valuable healing knowledge may be lost or diluted. Efforts to document and preserve traditional healing practices, such as through oral history projects, ethnographic studies, and community-based initiatives, help safeguard this knowledge for future generations. In addition to cultural and linguistic barriers, legal and regulatory barriers may impede the integration of ancient healing traditions into modern healthcare systems.

Many traditional healing practices, such as herbal medicine and TCM, are subject to different regulatory frameworks and standards of practice than conventional biomedicine. This can create challenges for practitioners seeking to integrate traditional therapies into mainstream healthcare settings, as they may face obstacles such as licensure requirements, insurance coverage, and liability concerns. Streamlining regulations and fostering collaboration between traditional healers and biomedical practitioners can facilitate the integration of ancient healing traditions into modern healthcare.

Despite these challenges, there are also significant opportunities for revitalizing ancient healing traditions and incorporating them into modern healthcare systems. One opportunity is the growing interest in complementary and alternative medicine among patients and healthcare providers. Many people are seeking alternatives to conventional medical treatments. They are turning to ancient healing traditions such as acupuncture, herbal medicine, and mindfulness-based therapies for relief from chronic conditions and improved quality of life.

By integrating complementary and alternative medicine therapies into mainstream healthcare settings, providers can offer patients a more comprehensive and holistic approach to health and wellness. Another opportunity is the recognition of the cultural relevance and diversity of healing practices within multicultural societies. As societies become increasingly diverse and multicultural, there is a growing recognition of the importance of culturally competent healthcare that respects and integrates diverse healing traditions.

By incorporating cultural competence training into medical education and practice, healthcare providers can better understand and address diverse communities’ unique health beliefs and practices, leading to more effective patient-centered care. Furthermore, advances in technology and communication offer new opportunities for preserving, disseminating, and adapting ancient healing traditions for modern contexts.

Digital platforms, such as online databases, mobile apps, and telehealth services, can access traditional healing knowledge and resources, regardless of geographic location. Virtual platforms also enable traditional healers and biomedical practitioners to collaborate and share knowledge, fostering interdisciplinary approaches to health and wellness. By harnessing the power of technology, we can bridge the gap between ancient healing traditions and modern healthcare, ensuring that traditional wisdom continues to enrich and inform our understanding of health and healing.

Technological innovations in medical instruments have revolutionized healthcare delivery, diagnosis, and treatment, leading to improved patient outcomes and increased efficiency in healthcare systems. From the invention of the stethoscope in the early 19th century to the development of advanced imaging techniques and robotic surgical systems in the 21st century, technological advancements have transformed the practice of medicine and expanded the possibilities for diagnosis and treatment across a wide range of medical specialties.

Advances in nanotechnology and biotechnology have led to the development of novel medical devices and therapies with unprecedented precision and specificity. Nanomedicine, which uses nanoscale materials and devices for diagnosis, drug delivery, and tissue engineering, holds promise for revolutionizing cancer treatment, regenerative medicine, and personalized medicine. For example, nanoparticle-based drug delivery systems can target cancer cells with high specificity, minimizing side effects and improving therapeutic outcomes. Similarly, 3D printing technology allows the fabrication of custom-designed medical implants, prosthetics, and tissues, offering new possibilities for personalized medicine and regenerative therapies.

Global perspectives on ancient healing traditions offer a rich tapestry of diverse cultural practices, beliefs, and therapeutic modalities that have evolved over millennia to address the health needs of different societies and communities. From TCM in East Asia to Ayurveda in South Asia, and from shamanic healing practices in indigenous cultures to Hippocratic medicine, each tradition reflects the unique cultural, environmental, and historical contexts in which it developed. Despite their differences, these ancient healing traditions share common holistic health, balance, and harmony themes, offering valuable insights into the interconnectedness of mind, body, and spirit.

In East Asia, TCM has been practiced for over 2000 years and continues to play a prominent role in healthcare in China and other Asian countries. TCM encompasses a range of therapeutic modalities, including acupuncture, herbal medicine, massage (tui na), dietary therapy, and qigong exercises, all aimed at restoring balance and harmony within the body. TCM views health as a state of balance between yin and yang, 2 opposing forces representing different aspects of the natural world, and seeks to address the root causes of illness rather than just the symptoms.

In South Asia, Ayurveda, the traditional medicine of India, has a similarly long history and remains an integral part of healthcare in India and neighboring countries. Ayurveda emphasizes the importance of balance and harmony within the body and with the natural environment and offers a comprehensive system of diagnosis and treatment based on the individual constitution (dosha), lifestyle factors (diet, exercise, sleep), and herbal remedies. Ayurvedic treatments aim to restore balance within the body and promote overall well-being through dietary changes, lifestyle modifications, herbal medicines, and detoxification therapies.In indigenous cultures worldwide, shamanic healing practices have been practiced for millennia, drawing on spiritual beliefs, ritual ceremonies, and plant medicines to treat illness and promote healing.

Shamans, or spiritual healers, serve as intermediaries between the human and spirit worlds, using divination, trance states, and energy healing techniques to diagnose and treat illness. Shamanic healing traditions vary widely across different cultures and regions but share common themes of connection to nature, reverence for ancestral wisdom, and respect for the healing power of plants and spirits. Hippocratic physicians laid the foundation for modern medical ethics and practice.

The Hippocratic Corpus, a collection of medical texts attributed to the ancient Greek physician Hippocrates, emphasized the importance of observation, clinical reasoning, and ethical conduct in medicine. Hippocratic physicians viewed health as a balance of the 4 humors (blood, phlegm, yellow bile, and black bile). They sought to restore balance through dietary changes, physical therapies, and herbal remedies. Despite their historical and cultural differences, ancient healing traditions influence modern healthcare systems and practices worldwide. In recent years, there has been growing interest in integrating traditional healing modalities into mainstream healthcare settings as policymakers, healthcare providers, and patients recognize the value of holistic approaches to health and wellness.[[7](https://pmc.ncbi.nlm.nih.gov/articles/PMC11245246/#R7)] Integrative medicine, which combines conventional biomedicine with complementary and alternative therapies, seeks to provide patients with a more comprehensive and personalized approach to healthcare that honors the diversity of human healing traditions.

Advances in scientific research and technology have provided new opportunities for studying and validating the efficacy of ancient healing practices, leading to a growing body of evidence supporting their use in modern healthcare. Studies have shown that acupuncture is effective for treating chronic pain, herbal medicines have therapeutic benefits for various health conditions, and mindfulness-based interventions can reduce stress, anxiety, and depression. By integrating ancient healing traditions with modern medical science, we can create a more holistic, patient-centered approach to healthcare that addresses individuals’ and communities’ physical, emotional, and spiritual needs.

The future of healing lies in integrative and holistic approaches that combine the best of modern medical science with ancient healing wisdom to address the complex needs of individuals and communities. As our understanding of health and wellness continues to evolve, there is a growing recognition of the interconnectedness of mind, body, and spirit and the importance of addressing the root causes of illness rather than just the symptoms.  Integrative and holistic approaches to healing offer a comprehensive and personalized approach to healthcare that honors the diversity and richness of human healing traditions while harnessing the power of modern medical technology and research.

One of the key principles of integrative and holistic healing is the recognition of the interconnectedness of mind, body, and spirit and the importance of addressing the underlying causes of illness. Rather than solely treating symptoms, integrative and holistic practitioners seek to identify and address the root causes of illness, including physical, emotional, psychological, social, and spiritual factors. By taking a whole-person approach to healing, practitioners can create personalized treatment plans that address each individual’s unique needs and preferences, leading to better outcomes and improved quality of life.

Another fundamental principle of integrative and holistic healing is the emphasis on preventive healthcare and lifestyle interventions. Rather than waiting until illness, integrative and holistic practitioners promote health and wellness through healthy living practices, such as proper nutrition, regular exercise, stress management, and mind-body techniques. By empowering individuals to take an active role in their health and well-being, practitioners can help prevent chronic diseases, reduce healthcare costs, and improve overall quality of life. Integrative and holistic healing also recognizes the importance of cultural competence and diversity in healthcare. By honoring the diversity of human healing traditions and respecting the cultural beliefs and practices of individuals and communities, practitioners can create a more inclusive and welcoming healthcare environment that meets the needs of all patients.

Cultural competence training, diversity initiatives, and community partnerships can help healthcare providers better understand and address the unique health challenges and disparities different populations face, leading to more equitable and effective care. Integrative and holistic healing embraces complementary and alternative therapies in conjunction with conventional medical treatments to enhance healing and promote well-being. Modalities such as acupuncture, herbal medicine, massage therapy, chiropractic care, and mind-body therapies offer valuable tools for managing pain, reducing stress, improving sleep, and supporting overall health and wellness.By integrating these therapies into mainstream healthcare settings, practitioners can offer patients a more comprehensive and personalized approach to healing that addresses health’s physical, emotional, and spiritual dimensions.

Medical technology and research advances also provide new integrative and holistic healing opportunities. From genomic medicine and personalized nutrition to biofeedback and telemedicine, technology is revolutionizing how we understand and approach health and wellness. By harnessing the power of big data, artificial intelligence, and digital health tools, practitioners can personalize treatment plans, predict disease risk, and monitor patient outcomes in real-time, leading to more precise and effective interventions.The religious and spiritual dimensions of healing encompass many beliefs, practices, and traditions that play a central role in how individuals and communities understand and experience health, illness, and well-being.

Across cultures and religions, spiritual beliefs and practices have long been intertwined with healing concepts, offering solace, hope, and meaning in times of illness and suffering. From prayer and meditation to rituals and sacred ceremonies, religious and spiritual traditions provide diverse pathways to healing that address the physical, emotional, and spiritual dimensions of human existence. One of the central themes in religious and spiritual dimensions of healing is the belief in a higher power or divine force that guides and sustains life. In many religious traditions, such as Christianity, Islam, Judaism, Hinduism, Buddhism, and indigenous spiritualities, prayer is a central practice that connects individuals to the divine and invokes divine intervention for healing and protection.

Prayer can take many forms, including silent meditation, recitation of sacred texts, communal worship, and intercessory prayer, and is often accompanied by rituals, symbols, and ceremonies that invoke the presence and blessing of the divine. Another key theme in religious and spiritual dimensions of healing is the belief in the interconnectedness of mind, body, and spirit and the importance of addressing the spiritual dimensions of health and well-being. In many religious and spiritual traditions, illness is seen not only as a physical or psychological condition but also as a manifestation of spiritual imbalance or disconnection from the divine. Healing, therefore, involves restoring harmony and alignment within the individual and with the cosmos through practices such as prayer, meditation, confession, forgiveness, and acts of compassion and service. Rituals and ceremonies are also central to religious and spiritual dimensions of healing, providing sacred spaces and moments for individuals and communities to express their faith, seek guidance, and receive blessings for healing and wholeness.

Rituals may involve symbolic actions, gestures, objects, and words that evoke spiritual power and presence, such as lighting candles, burning incense, chanting prayers, and making offerings.  These rituals create a sense of sacredness and sanctity that transcends the ordinary and connects individuals to the divine and one another in a shared journey of healing and transformation. Sacred texts and teachings are another source of inspiration and guidance in the religious and spiritual dimensions of healing, offering wisdom, comfort, and guidance for navigating the challenges of illness and suffering. In traditions such as Christianity, Islam, Judaism, Hinduism, and Buddhism, sacred texts such as the Bible, the Quran, the Torah, the Vedas, and the Sutras contain stories, parables, and teachings that offer insights into the nature of suffering, the meaning of healing, and the role of faith and devotion in finding solace and strength in times of trial. These texts inspire comfort and hope for individuals and communities facing illness and adversity. The role of religious and spiritual leaders and healers is also significant in religious and spiritual dimensions of healing, as they serve as intermediaries between the divine and the human realm, offering guidance, support, and blessings for healing and transformation. Religious leaders, such as priests, pastors, rabbis, imams, and shamans, often play a central role in providing pastoral care, counseling, and spiritual support to individuals and families facing illness and loss. Spiritual healers, such as shamans, medicine men, and faith healers, may use rituals, prayers, herbs, and other sacred practices to invoke divine healing and protection for those in need.

In recent years, there has been growing interest in integrating religious and spiritual dimensions of healing into mainstream healthcare settings, as healthcare providers recognize the importance of addressing the spiritual dimensions of health and well-being for holistic care. Studies have shown that religious and spiritual beliefs and practices can significantly affect health outcomes, including reduced stress, anxiety, depression, and improved quality of life. By integrating spiritual care into medical practice, healthcare providers can create more compassionate, patient-centered care environments that honor the diversity of human beliefs and experiences.Ritual and symbolism play profound roles in healing across cultures and traditions, offering powerful mechanisms for individuals and communities to navigate the complexities of illness, suffering, and transformation. Rooted in ancient practices and imbued with cultural significance, rituals, and symbols provide frameworks for meaning-making, connection, and healing that transcend the boundaries of language and rational understanding.

From ceremonies that mark significant life transitions to symbolic objects and gestures that invoke spiritual power, ritual and symbolism serve as potent tools for navigating the human experience of illness and suffering. At the heart of ritual and symbolism in healing lies the recognition of the interconnectedness of mind, body, and spirit and the importance of addressing the spiritual dimensions of health and well-being. Across cultures and traditions, rituals are often performed to create sacred spaces and moments that invite divine presence, offer protection, and facilitate healing. These rituals may involve symbolic actions, gestures, objects, and words that evoke spiritual power and presence, such as lighting candles, burning incense, chanting prayers, and making offerings. By engaging the senses and the imagination, rituals create a sense of sacredness and sanctity that transcends the ordinary and connects individuals to the divine and one another in a shared journey of healing and transformation.

One of the most common rituals in healing practices is the use of ceremony to mark significant life transitions, such as birth, puberty, marriage, and death. These ceremonies often involve symbolic actions and rituals that honor the transition and provide support and guidance for individuals and communities as they navigate new phases of life. For example, traditional healing ceremonies in indigenous cultures may involve rites of passage that mark the transition from childhood to adulthood and prepare individuals for their roles and responsibilities within the community. Rituals surrounding death and dying offer opportunities for individuals and families to grieve, remember, and honor the deceased while also providing comfort and support for the journey of the soul into the afterlife. Symbols are also central to the healing process, potent vehicles for meaning-making, transformation, and connection.

Symbols are powerful tools for communication, conveying complex ideas and emotions concisely and evocatively. In healing, symbols may take many forms, including objects, images, colors, sounds, and gestures, each imbued with cultural, religious, and personal significance. For example, the cross symbolizes sacrifice, redemption, and healing in Christianity, while the lotus flower represents purity, enlightenment, and spiritual rebirth in Buddhism.

By evoking these symbols, individuals can tap into their deeper meanings and associations, finding solace, strength, and inspiration in times of need. Rituals and symbolism also play essential roles in psychological healing and transformation, offering opportunities for individuals to make meaning of their experiences, integrate their emotions, and find closure and resolution. In psychotherapy, rituals and symbols are often used to access and process unconscious material, facilitate emotional expression, and promote healing and growth. For example, guided imagery, dream work, and expressive arts therapy can help individuals explore their inner worlds, access their creativity, and work through unresolved issues and traumas.

Symbols, such as archetypes, metaphors, and myths, provide rich material for exploring the deeper layers of the psyche and uncovering hidden patterns and meanings. Rituals and symbols can create therapeutic environments that promote relaxation, stress reduction, and emotional well-being. In healthcare settings, rituals such as lighting candles, playing soothing music, and engaging in mindfulness practices can help create a sense of calm and comfort for patients and caregivers. Similarly, symbols such as healing crystals, sacred images, and religious icons can serve as focal points for meditation, prayer, and reflection, providing individuals with sources of strength and inspiration during illness and recovery.

The use of ritual and symbolism in healing is not limited to traditional or religious contexts but extends to various secular and contemporary practices. For example, weddings, graduations, and funerals often incorporate symbolic actions and gestures that mark the occasion’s significance and give participants closure and meaning. Similarly, symbols such as flags, logos, and monuments serve as powerful expressions of collective identity, memory, and values, uniting communities and inspiring shared visions of the future.

The journey through the evolution of ancient healing practices, from shamanism to Hippocratic medicine, reveals a rich tapestry of diverse traditions, beliefs, and techniques that have shaped the healthcare landscape throughout history. From the spiritual rituals of indigenous shamans to the rational principles , each tradition offers unique insights into the human experience of illness, suffering, and healing. Despite their differences, these ancient healing practices share common themes of holistic health, balance, and harmony, emphasizing the interconnectedness of mind, body, and spirit.

The wisdom and knowledge passed down through generations continue to inspire and inform modern approaches to healthcare, offering valuable lessons for addressing the complex needs of individuals and communities in today’s world. From integrative medicine that combines the best of ancient wisdom and modern science to culturally competent care that honors the diversity of human beliefs and experiences, there are many opportunities to revitalize ancient healing traditions and integrate them into contemporary healthcare systems. By bridging the gap between ancient wisdom and modern science, preserving and honoring the cultural heritage and wisdom of ancient healing practices together embracing the possibilities for innovation, collaboration, and transformation in healthcare at the same time and by fostering interdisciplinary dialogue, supporting research and education, and promoting policies prioritizing holistic, patient-centered care, with a more holistic, equitable, and sustainable approach to healing that honors the interconnectedness of all beings and promotes health and well-being for next generations, a more inclusive, compassionate, and effective healthcare system that honors the diversity and richness of human healing traditions can be created. (135-141)

**HEALING**

Healing comes from the Old English word haelan meaning “whole” and thus signifies the process of becoming more whole or assisting another in that endeavor, even during failing health or death.Systems of hands-on energy healing are found throughout the world, across cultures and religions. Some of these systems of healing originate in longstanding traditions of folk medicine, some derive from ancient wisdom traditions, others are identified with particular individuals whose innovations gave birth to newer schools of healing in modern times.

A distinct class of practitioners known as healers has existed since the beginning of recorded history. The lineages of the myriad contemporary schools and philosophies of healing can be traced back hundreds and even thousands of years through great systems of esoteric learning, mystical spirituality, and arcane medical science. The mystery schools of the great ancient civilizations of Egypt, Babylonia, Assyria, Phoenicia, India, Iran, Greece, and Rome contained deep fonts of wisdom about healing accessible to spiritual initiates, adepts, and priest-physicians. Later on, monastic orders of healers, such as the neo-Essene Therapeutae, practiced forms of healing derived from insights gained through meditation and metaphysical speculation.

Medieval brotherhoods and orders of hermetic and Rosicrucian origin promulgated systems of graded initiation that included instruction on healing techniques grounded in clairvoyant diagnosis and distant mental intention. Central to the teachings of Eastern and Western mystical traditions, from Tibetan Buddhism to systems of European esotericism such as Theosophy and its offshoots, were explicit teachings about touch, noncontact, and absent healing based on understandings of the connectedness of all life through a substrate of circulating subtle energy. Other traditions, from kabbalism to shamanism to more contemporary new age philosophies, also promulgate methods of healing accessible to students or initiates.

**Mysticism**

While mysticism plays an essential, role in all the world's religions, mysticism itself is not a religion, but it is practiced in different religions of the world. Mysticism is within most religious beliefs, meditations, and mystical experiences. There are Christian mystics, Jewish mystics, Muslim mystics, Buddhist mystics, Hindu mystics, Protestant mystics, and Catholic mystics. Mysticism can be identified as the study of life by which a person becomes enabled to realize the spiritual realities and profound principles of life, ranging from the biological through the psychological to the theological. The origin of the word and its features suggest that mysticism is the science of a hidden life.

Muhammad, the man responsible for starting “Islam,” had a mystical experience, which could be described as trophotropic or ergotropic. One night Muhammad was lying still in his bed and all of a sudden he was traveling through the heavens. He traveled through the seven heavens, where he saw many prophets from the past. He saw Abraham, Jesus, Moses, and many others and talked to the prophets as if they were human just like himself. This experience, eventhough only a vision, became a significant changing point in his life. He traveled far into the seven heavens and even beyond them. As he surpassed the seventh heaven, he came to point where he could not go any further. Muhammad looked into the vastly lighted vicinity and couldn’t clearly see anything. The technique that most mystics use is some form of meditation or contemplation.

During meditation, one begins to slow down the thinking process, with fewer or less intense, distant, vague, or less preoccupying thoughts; one stops paying as much attention to bodily sensations with fewer or less intense fantasies and daydreams. When the intensity or compelling quality of outward perception and inward thoughts is reduced, one may come to a time of greater stillness. Ultimately, one may become utterly silent inside, as though in a gap between thoughts, where one becomes completely unperceptive, and thought-free.

One neither thinks nor perceives any mental or sensory content. Despite this suspension of content, one emerges from such events confident and remained awake inside, fully conscious. A mystic claims to attain, or believes in the possibility of attaining insight into mystical realms beyond the knowledge of mankind by reaching the highest level of spiritual ecstasy. Whether Hindu, Buddhist, Christian, or Muslim, the mystic seeks by contemplation and self-surrender to obtain union with, or absorption into, the deity, or believes in the possibility of the spiritual apprehension of truths that are inaccessible to the ‘normal’ understanding.

Mysticism plays a significant part in Buddhism. A man by the name of Gautama felt that life had more to offer than worldly pleasures. He was born in 563 B.C. near the border of India. His childhood was very glamorous. He wore clothes of silk. He possessed elephants that wore ornaments. He had never seen any ugly people because his father would not allow ugliness into the house. Even when the driver took Gautama for rides, servants would walk ahead and clear the road of anybody that was ugly, decrepit, diseased, or dead. So Gautama didn’t see anything like that for almost all of his childhood, until one day when they were traveling the same path and came upon a man that was decrepit, broken-toothed, gray-haired, crooked and bent of body, and trembling. Gautama didn’t know what to do. He ordered his driver to stop! The servants had no idea how this man had gotten there because they had already checked the road thoroughly. The old man was considered to be incarnated by Gods to give him the needed lesson.

The next day he encountered a man racked with disease, and on the third day a man lying dead on the side of the road. On the forth day, he met a monk with a shaven head and an ochre robe. It was that day that he learned of the life of withdrawal from the world. Once he experienced the inevitability of pain and death, world pleasure lost its charm. When he was twenty-nine year of age, he set out to live in the wilderness in order to rejoice in solitude. He went through several phases during his quest. He learned a great deal about the Hindu philosophy. Gautama devoted his final phase to rigorous thought and mystic concentration. One evening, near Gaya, India, he sensed that awakening was near, so he sat down near the Bo tree (short for bodhi or enlightenment). He sat in meditation while evil ones tried to tempt him with women. They tried to scare him with dangerous hurricanes and terrible thunderstorms, but he did not move. He sat there and soon the awakening had arrived. He had been transformed into Buddha.

Mystical traditions exist within nearly every major religion and spiritual path. While diverse in form, these traditions share a common aim: to transcend the limitations of the ego and intellect in order to experience a direct, transformative relationship with the Divine. These mystical paths emphasize inner experience over mere doctrine and point to the heart as the true temple of divine encounter. Mystical traditions across the world offer different maps of the spiritual journey—but all point toward the transformation of the self through love, stillness, and interior awakening. Whether through Christian contemplation, Sufi ecstasy, Zen mindfulness, or Kabbalistic symbolism, the mystic becomes a pilgrim of the unseen—one who walks the inner path not merely to know God, but to encounter and embody the Divine.

Christian mysticism emphasizes personal union with God through love, contemplation, and interior transformation. Christian mystics seek to “put on the mind of Christ” not just intellectually, but experientially. Practices include contemplative prayer, lectio divina, solitude, fasting, silence. Many mystics describe a threefold path of purification, illumination, and union—a journey from detachment to divine intimacy. Kabbalah is a form of Jewish mysticism that explores the hidden aspects of God (Ein Sof) and the spiritual structure of the universe through symbolic language and sacred geometry. Central to Kabbalistic cosmology is the Tree of Life, composed of ten sefirot—emanations through which the infinite God interacts with creation. The Zohar, a 13th-century mystical commentary on the Torah, is considered the foundational text of Kabbalah. Kabbalistic meditation involves visualizing divine names, Hebrew letters, or sefirot and may include chanting (hitbodedut) or silent communion.

Sufism is the mystical branch of Islam that seeks the direct, experiential knowledge of God through love, devotion, and remembrance (dhikr). Sufis emphasize the inner dimension of the Islamic faith—transforming the heart through humility, purification, and ecstatic longing for the Divine.

 Practices include:

* Chanting the names of God (dhikr)
* Whirling or other bodily movements (as in the Mevlevi order)
* Meditation and spiritual poetry
* Following a tariqa, or path under a spiritual guide (sheikh or murshid)

Notable sufis:

Rumi, expressed divine love in mystical terms with poetry,

* Hafiz, is known for his lyrical celebration of beauty and union
* Al-Ghazali, a theologian-mystic reconciled Islamic orthodoxy with inner experience

Hindu mysticism encompasses numerous schools and spiritual paths. At its core, the individual soul (atman) is one with the absolute divine reality (Brahman)—a truth realized through inner transformation and yogic discipline.

 Major mystical paths include:

* Bhakti Yoga (devotion) – fostering love and surrender to a personal deity
* Jnana Yoga (knowledge) – contemplation and self-inquiry into ultimate reality
* Raja Yoga (meditation) – using concentration and inner stillness to attain spiritual liberation
* Kundalini Yoga – awakening latent spiritual energy through breathwork, posture, and mantra

Texts such as the Bhagavad Gita, Upanishads, and Yoga Sutras serve as foundational sources for Hindu mystical teaching

Buddhist mysticism focuses not on union with a personal deity but on the realization of emptiness (śūnyatā), impermanence, and the interconnectedness of all things. Enlightenment (nirvana) is achieved through direct insight, cultivated by ethical living and disciplined meditation.

 Core practices include:

* Mindfulness meditation (vipassana) – observing thoughts, emotions, and sensations without attachment
* Zazen (seated meditation) – practiced in Zen Buddhism, emphasizing direct experience without reliance on scripture or intellect
* Visualization practices – especially in Vajrayana and Tibetan Buddhism
* Mantra and ritual – used in Mahayana and Tantric traditions

 Mystical insights are described not as supernatural experiences, but as deeply ordinary awakenings to the nature of mind and reality.

Taoist mysticism originated in ancient China , emphasizes harmony with the Tao—the ineffable, spontaneous source of all life and teaches that spiritual realization comes through wu wei (non-striving), stillness, and alignment with natural rhythms.

Mystics in this tradition cultivate:

* Qi (life energy) through breathwork and gentle movement (e.g., qigong, tai chi)
* Meditation and internal alchemy – transforming the inner body and spirit
* Contemplation of nature – learning from the cycles and subtleties of the natural world
* Sacred texts, such as the Tao Te Ching and Zhuangzi, which offer poetic insights into cosmic flow and paradox

 Taoist mysticism is less about doctrinal precision and more about surrendering to the mystery of existence with humility and grace.(142-143)

**Trauma therapy**

Trauma has no panoptic definition, but is considered to be the physical and psychological attachment to traumatic memories that negatively affect individuals’ life by overwhelming symptoms with no physical explanation, such as changes in sleep or appetite, low energy, lack of interest or pleasure in activities you once enjoyed, persistent irritability, excessive worry, or a sense of discouragement or hopelessness that won’t go away. Trauma is not just an experience from the past. The effects of trauma are imprinted not just in the consciousness but also on the brain, mind, and body. Trauma changes the chemistry of the brain and the physical body.

Psychotherapy (Talk therapy) alone cannot tap into the physical body to alter the physically housed imprints of trauma. As a result of a survival reaction to the trauma, the emotional brain (or limbic system) looses its filters and normal functioning as of the trauma either becomes hyper aroused (lashing out ) or hypo aroused ( feeing numb and spaced out) when triggered by memories of trauma. Trauma patients are unable to access their emotions appropriately or at all. At the core of recovery, there is self-awareness. Emotions being perpetuated by stress hormones and numbness and hyper arousal, are expressed as physical feelings: a pounding heart, headaches, dizziness, faintness, etc.

If trauma has made someone so out of touch with their body how can they regulate their emotions if they are not even aware that they are being expressed as physical sensations within their body? The traumatized people are afraid of processing their emotions because they do not feel them, if they could once an access in their bodies they would begin to recognize what is happening internally.

As patients remember traumatic memories and experiences, they physically move to give their bodies the opportunities to process traumatic events with movement, which was what their bodies wanted to do at the initial event. The amygdala (the body’s alarm system) realizes that it can stop ringing the alarm bell as if the traumatic event was still happening, stress hormones stop being released and the body returns to its base line of arousal as a result.

The Body Keeps the Score.Trauma therapy describes diverse methods that include the body, the mind, and the spirit to make treatments holistic and effective and unique by using the body as an integrative method to heal trauma. Body therapies such as Sensorimotor Processing and Somatic Experiencing focus on the physical body to process memories of trauma, and help patients reclaim their lives by helping them access and process traumatic memories so that a state of calmness and control reintegrated into their lives.

Unhealed trauma pass from parent to child and can manifest itself in learned cognitive philosophies that conceive the world to be a menacing place and behaviors such as violent outbursts or aggression, through clinically diagnosed symptoms like hyper vigilance and anxiety. Vicarious traumas can also be passed inter-generationally by stories and behaviors and disruptions in biology and development, which hinder a child from reaching healthy. (144)

**Healing touch vs reiki**

Energy healing is categorized under various names depending on what source is referenced: alternative medicine, spiritual healing, energy medicine, holistic health, and therapeutic approaches. Emotional Freedom Technique or Tapping, acupuncture, the use of crystals, reflexology, and chakra balancing. Over the past several decades, researchers have been interested in the effects and potential mechanisms of certain energy-healing practices such as Therapeutic and Healing Touch, and Reiki. As a result, practitioners of traditional medicine so-called “energy healers” have been involved in a wide number of studies. Philosophically, each of these biofield therapies relies on a “vital force” as the main driving mechanism of health, pathogenesis, and healing. This philosophical approach is an ancient and shared concept understood, as Qi, Ki, Prana, Ankh,and Pneuma in Chinese, Japanese, Hindu, Egyptian, and Greek cultures, respectively.

Reiki, a Japanese originated word, can be understood by splitting the word in half; the prefix ‘Rei’ means “’God’s Wisdom or the Higher Power’” and the suffix ‘Ki’ means “’life force energy’” Together Reiki that translates to “’spiritually guided and directed life force energy’” , is a gentle hands-on spiritual healing tradition to support the body’s own natural healing process as a safe way to help overcome both physical and psychological ailments. During a Reiki session practitioners place their hands over or on a patient’s body to help channel the flow of energy throughout their body with the goal of facilitating the person’s own healing response. In the tradition of the Japanese sensei (teacher), Reiki is passed on from master to student through attunement, an initiatory ceremony facilitated through the laying on of hands. This attunement is understood to open the student’s energy channels, thus facilitating the flow of universal life energy for treating others and oneself. Reiki master teachers trace their lineage back to Usui. Reiki is taught at three levels: basic hands-on healing, distance healing, and master teacher. Although students learn basic hand placements, the “teaching” in Reiki lies in the practice.

By offering Reiki, the practitioner receives benefit from the same universal life energy that flows to the recipient. The more the practitioner treats self and others, the more in tune he or she is with energy flow and balance. Each course level with its corresponding attunement raises the practitioner’s vibrations to higher healing frequencies. The master level prepares practitioners as teachers who can then pass on attunements to students. There is no assessment or attempt to manipulate or balance the energies. The Reiki method allows the flow of universal life energy to the recipient, who in turn uses it where needed. Recipients experience deep relaxation, relief from anxiety and pain, and an increased sense of well-being.

Reviews of TT research has demonstrated positive outcomes suggesting reduced stress-related conditions, anxiety, and pain; some improved biomarkers; accelerated healing; increased perception of well-being ; and improved health-related quality of life. When first created by a Buddist Monk named Mikao Usui in 1922, Reiki used the concept of tandens or energy centers in the body and originally focused specifically on one main tanden located in the lower abdominal. In modern day energy therapies the Hindu chakra system has taken over.

Chakra, as a Sanskrit word translates to wheel, vortex, or whirlpool. Chacras are centers in bodies where energy flows and can be manipulated by energy therapies. Tandens and chakras are the same thing, but instead of focusing on one main tanden the chakra system focuses on seven main energy centers, the top of the head, the forehead, throat, heart, solar plexus, navel, and the bottom of the pelvis. The seven different chakras correspond to and affect different organs, glands, bodily functions, and psychological and emotional conditions.

Reiki and Healing Touch are meant to unblock and balance the seven chakras to heal an individual in a holistic way, similar to trauma healing practices that incorporate the physical, emotional, psychological, and spiritual aspects of a person. The Healing Touch practitioner unblocks energy through the body promoting physical healing and emotional, mental, and spiritual balance. The goal of Healing Touch is to restore harmony and balance in the energy system to help the person self-heal.

The symptoms of negative physiological issues that result from serious disease include pain, and reduced stress and heart rate variability. Energy therapies lower blood pressure and respiratory rate, lessen mood disturbances, helps with relaxation, and a general sense of well-being, reduce anxiety, depression, cynicism and seizures, drop in PTSD symptoms, greater quality of life, less stress, and fatigue.

A framework can be established and implemented to indicate the healing process:

1. Finding a way to be calm and focused

• Dealing with hyper arousal

2. Learning to maintain that calm

• Mindfulness

• Self-regulation

• Overall psychological improvement (addictions, attention span, ability to learn, etc.)

3. Finding a way to be fully alive in the present and engaged with thepeople around you

• Communal rhythms and synchrony

• Feeling safe

• Feeling your physical body in a healthy way – feeling like “somebody”

4. Not having to keep secrets from yourself

• Daring to tell the truth

• Self-discovery/self-leadership – knowing yourself

• Rescripting your life

• Self-compassion

Reiki and Healing Touch treatments are seen to be effective in participants’ lives in a holistic way. Participants’ overall quality of life was bettered physically, emotionally,and spiritually with relationships with family and friends, and within their personal and professional lives through energy therapy.In healing touch, an understanding of the 12 meridians and the chakras and learning hands-on therapeutic skills in opening blocked energies is essential. It requires the gentle use of hands from practitioner to receiver. Healing Touch is a method of altering the body's energy system to influence self-healing.

Reiki is channeling the universal life energy known as qi to stimulate the integration of mind, body, and spirit to enhance the natural healing mechanism. If the practitioner's qi is blocked, it will hinder their healing capabilities. In Reiki, the strokes are similar to those found in Healing Touch, but they are done close to the body, not directly on the body. This makes Reiki a more comfortable practice for those who dislike being touched.

Origins and Philosophy

Healing touch: Janet Mentgen, a registered nurse, has developed healing touch based on the scientific understanding of the human energy field concept that the body’s energy system can be balanced and cleared of blockages to promote healing.

Reiki : a Japanese technique founded by Mikao Usui. Reiki comes from Japanese words rei (universal ) and Ki (life force energy), which tarnslates to universal life force energy and involves the channeling of energy through te hands of the practitioner with the belief that this energy supports the body’s natural healing abilities.

Approach and Techniques:

Healing Touch : uses the practitioner’s hand movements to move energy through the body and remove blockages as well as visualization of specific hand movements and a focus on maintaining the flow of energy.

Reiki : Lack of visualization makes reiki more passive and the practiitoner acts just as a conduit for the energy rather than making energy flow a particular way.

Practitioner role

Healing touch : The practitioner is more actively involved in guiding the energy using intention, focus and specific techniques to direct healing. They are trained to assess and balance energy fields, using a step by step process to clear blockages and restore balance.

Reiki : The practiioner focus more on being the conduit for the universal energy. They do not direct energy consciously, but instead they trust that energy would go where it is needed. They use specific hand positions with less active manipulation.

Training and certificate

Healing touch : requires a structured training program including multiple levls based formal certification processes

Reiki : Training is divided into several levels or degrees. Reiki master pass on attunements that are believed to open the energyb pathways for others.

Focus

Healing touch : focuses on balancing the energy field restoring harmony within the body , mind and spirit. It aims to support emotional, mental, physical and spiritual healing with greater emphasis on clearing energy blockages that affect physical health.

Reiki : it is more spiritually oriented. While it can promote physical healing, reiki practiitoners focus on spiritual and emotional well-being and connecting with universal life force energy tol et it flow freely to heal the recipient.

Scientific Basis

Healing touch : As an energy medical practice, research has focused on its physiological effects on pain, stress, anxiety and physical healing.

Reiki : The ouıtput of reiki in reducing stress, anxiety and pain has been more evaluated.

Short version

Healing touch : The structured, active and directive use of specific techniques to actively clear blockages and balance energy fields. The focus is onb improving the individiual’s emotional and spiritual health and well being.

Reiki: More flowing but passive and less directive in chanelling universal energy, reiki relies on the wisdom of the universal life force to do what the individual needs in that moment and focuses more on spiritual and emotional healing.



The human body has a subtle energy system that interpenetrates the physical anatomy and extends outward beyond it.

• This subtle energy may be conceptualized as universal energy or vital energy flowing through and available to all beings.

• The normal self-healing capacity of the human body is supported by the free and balanced flow of energy through its subtle energy system.

• Disease or disorder can be detected in the energy system before it manifests

in the physical body and can be affected therapeutically by the action of energy practitioners, in support of the self-healing capacity of the body.

• Conscious healing intent and compassion are considered essential to the effectiveness

of biofield therapies.

• Practitioners’ hands may or may not touch the body. Practitioners also may carry out

healing work mentally, from a distance. (145)

**Therapeutic Touch (TT)**

The Therapeutic Touch International Association describes TT as a contemporary interpretation of several ancient healing practices, with an intentionally directed process of energy exchange during which the practitioner uses the hands as a focus to facilitate the rebalancing of another’s energy field in support of healing. Therapeutic Touch restores balance through mobilizing the body’s innate healing energy processes to relieve stress; support immune function, wound healing, and bone repair; decrease side effects of cancer treatment with relaxation and feelings of well-being. Treatment response is individualized; repeated treatments may be required. Therapeutic Touch can be used for maintaining balance in the healthy individual as well. The history of TT is one of observation, application, and inquiry.

A noncontact intervention, TT is an individualized therapy administered in the recipient’s energy field through the healer’s hands. During treatment, which lasts for 10 to 20 minutes, the recipient (fully clothed) sits in a chair or lies on a massage table. A five-step process includes

(1) centering in the present moment,

(2) assessing the energy field by holding the hands 2 to 6 inches from the body while moving them methodically downward from head to foot,

(3) intervention to mobilize the energy field,

(4) balancing/rebalancing through directing energy toward healing, and

(5) evaluation/closure, includes a final assessment.

Healing Touch is described as a relaxing, nurturing energy therapy administered through gentle touch to balance mental, emotional, spiritual, and physical well-being, supporting the person’s natural ability to heal.  “Healing Touch is a biofield therapy that encompasses a group of non-invasive techniques that utilize the hands to clear, energize, and balance the human and environmental energy fields”. Practitioners of HT use their hands in a heart-centered and intentional way to influence the human energy system (the energy field around the body and energy centers called chakras ; the caring relationship energetically facilitates health and healing (Healing Touch Program [HTP]

The practitioner following the basic steps of assessment, treatment/balancing, and evaluation with hands several inches off the body. The assessment involves observation for imbalances presenting as differences in temperature or sensation in any area of the person’s energy field, including the chakras. Originating in the Vedic or East Indian tradition, chakra is a Sanskrit word meaning “wheel.” Seven chakras, located at strategic regions on the front and back of the body (root, sacral, solar plexus, heart, throat, brow, and crown), act as transducers for the energetic body. Treatment includes both gentle touch and nontouch techniques over various body areas to balance the person’s energy field, including the chakras. Recipients usually report relaxation, pain relief, decreased anxiety, and an increased sense of well-being. (146)

**Qi Energy**

The concept of Qi (Chi) is fundamental to Traditional Chinese Medicine (TCM). Qi (氣) can be translated as “vital energy” or “life force,” and its significance is deeply embedded in Chinese culture and philosophy. The Chinese character for Qi combines “mǐ” (米), meaning “rice,” and a symbol representing “steam” or “vapor.” This imagery of steam rising from cooking rice embodies Qi’s dynamic and transformative nature, illustrating the interplay of visible and invisible forces in life and the universe. **Qi** in TCM represents the **essential energy that sustains all living beings**, emphasizing the cyclical processes of growth, decay, and renewal. Whether referred to as Qi or Chi, this vital energy is central to understanding the principles and practices of TCM.

**Qi in Chinese Medicine**

In TCM, Qi is the vital substance that permeates and sustains all life. The body is viewed as a complex network of pathways through which **Qi flows**, and health is a reflection of the strength, balance, and unobstructed flow of Qi within these pathways. There are various forms of Qi, each with specific origins and functions, such as Yuan Qi, Gu Qi, Ying Qi, and Wei Qi. These forms work in harmony to regulate the body’s physiological processes, from digestion to immunity, maintaining overall well-being.

**Disease** in TCM is perceived as a **disruption in the flow** or **balance of Qi**—whether through deficiency, stagnation, or imbalance. TCM treatments like acupuncture, herbal medicine, and Qi Gong aim to restore the harmonious movement of Qi, promoting healing and health. This approach aligns with the Taoist principle of living in harmony with the natural rhythms and energies of the universe.

**Types of Qi in TCM**

* + 1. [Yuan Qi (元气) – Original Qi / Source Qi](https://yosan.edu/what-is-qi/#yuan)
    2. [Gu Qi (谷气) – Food Qi / Grain Qi](https://yosan.edu/what-is-qi/#gu)
    3. [Zong Qi (宗气) – Gathering Qi / Ancestral Qi](https://yosan.edu/what-is-qi/#zong)
    4. [Wei Qi (卫气) – Defensive Qi](https://yosan.edu/what-is-qi/#wei)
    5. [Ying Qi (营气) – Nutrient Qi / Nutritive Qi](https://yosan.edu/what-is-qi/#ying)
    6. [Zhen Qi (真气) – True Qi](https://yosan.edu/what-is-qi/#zhen)
    7. [Zhong Qi (中气) – Central Qi](https://yosan.edu/what-is-qi/#zhong)
    8. [Jing Qi (精气) – Essence Qi](https://yosan.edu/what-is-qi/#jing)
    9. [Qing Qi (清气) – Clean Air Qi](https://yosan.edu/what-is-qi/#qing)
    10. [Xie Qi (邪气) – Pathogenic Qi](https://yosan.edu/what-is-qi/#xie)

**Types of Qi in Traditional Chinese Medicine**

Qi is not a singular concept but manifests in various forms that regulate different aspects of health and bodily functions. Understanding these different forms allows practitioners to effectively diagnose and treat imbalances, restoring the natural flow of energy essential for health.

**1. Yuan Qi (元气) – Original Qi / Source Qi**

* **Origin**: Yuan Qi is derived from the prenatal Jing (Essence) and is inherited from the parents at conception. It is stored in the Kidneys.
* **Function**: Yuan Qi is considered the body’s vital essence and serves as the foundation of all other forms of Qi. It fuels growth, development, and the maintenance of life. Yuan Qi is also responsible for activating and driving the functions of the organs.
* **Pathway**: It is distributed throughout the body via the Triple Burner (San Jiao), particularly supporting the function of the Zang-Fu organs.
* **Clinical Significance**: Weak Yuan Qi can manifest in developmental delays, fatigue, or general weakness. It is also closely linked with kidney health.

**2. Gu Qi (谷气) – Food Qi / Grain Qi**

* + **Origin**: Gu Qi is produced by the Spleen and Stomach from the transformation of food and drink.
  + **Function**: It forms the foundation of the body’s postnatal energy. Gu Qi is further refined to become other forms of Qi, such as Ying Qi (Nourishing Qi) and Wei Qi (Defensive Qi), which are essential for sustaining life.
  + **Pathway**: Gu Qi is transported upward to the Lungs and Heart, where it is transformed into Ying Qi and Zong Qi (Gathering Qi).
  + **Clinical Significance**: Weak Gu Qi can lead to digestive problems, lack of energy, and malnutrition.

**3. Zong Qi (宗气) – Gathering Qi / Ancestral Qi**

* **Origin**: Zong Qi is created from the combination of Gu Qi (from food) and Qing Qi (Clean Air Qi) from the Lungs.
* **Function**: Zong Qi is responsible for the proper functioning of the Lungs and Heart, promoting respiration and circulation. It controls speech, the strength of the voice, and the ability to regulate breathing.
* **Pathway**: Zong Qi gathers in the chest (known as the “Sea of Qi”) and supports both the Lung function of inhalation and the Heart function of controlling blood circulation.
* **Clinical Significance**: Deficiency in Zong Qi can result in weak voice, shallow breathing, and poor circulation.

**4. Wei Qi (卫气) – Defensive Qi**

* **Origin**: Wei Qi is derived from Gu Qi and refined in the Lungs.
* **Function**: Wei Qi is responsible for defending the body against external pathogenic factors like wind, cold, heat, and dampness. It circulates on the surface of the body, between the skin and muscles, regulating body temperature and opening/closing the pores.
* **Pathway**: It is distributed primarily by the Lungs and circulates on the exterior (skin and muscles) during the day, while at night it moves inward.
* **Clinical Significance**: Deficiency of Wei Qi can lead to frequent colds, flu, and other infections. Its dysfunction may also lead to improper sweating and temperature regulation.

**5. Ying Qi (营气) – Nutrient Qi / Nutritive Qi**

* **Origin**: Ying Qi is derived from Gu Qi and is closely linked with Blood (Xue). It circulates within the blood vessels and the internal organs.
* **Function**: Ying Qi is responsible for nourishing the organs and tissues. It works more internally than Wei Qi and supports the function of Zang-Fu organs, promotes growth, and maintains overall health.
* **Pathway**: Ying Qi flows in the meridians and is distributed through the blood to nourish and maintain body functions.
* **Clinical Significance**: Weak Ying Qi can lead to anemia, poor nourishment of tissues, and general fatigue.

**6. Zhen Qi (真气) – True Qi**

* **Origin**: Zhen Qi is the most refined and usable form of Qi in the body. It is derived from Zong Qi after further refinement in the Lungs.
* **Function**: Zhen Qi is responsible for sustaining all the physiological functions in the body. It is divided into two forms: Ying Qi (Nutritive Qi) and Wei Qi (Defensive Qi).
* **Pathway**: Zhen Qi circulates through the entire body and is the final transformation of Qi from Yuan Qi, Gu Qi, and Qing Qi.
* **Clinical Significance**: Zhen Qi reflects the overall Qi health of the body.

**7. Zhong Qi (中气) – Central Qi**

* **Origin**: Zhong Qi refers to the Qi of the Middle Burner (Spleen and Stomach) and is closely related to postnatal Qi derived from food and drink.
* **Function**: It is responsible for the transportation and transformation of food and drink, and it helps maintain the upright position of the internal organs. It also plays a key role in digestion and absorption.
* **Pathway**: Zhong Qi is located in the middle Jiao and supports the function of the Spleen and Stomach.
* **Clinical Significance**: Deficient Zhong Qi can lead to prolapse of organs, weak digestion, bloating, and fatigue.

**8. Jing Qi (精气) – Essence Qi**

* **Origin**: Jing Qi is stored in the Kidneys and is derived from both prenatal Jing (inherited from parents) and postnatal Jing (produced from Gu Qi).
* **Function**: Jing Qi is responsible for growth, reproduction, and development. It provides the foundation for all physiological processes in the body, such as fertility, bone strength, and cognitive development.
* **Pathway**: Jing Qi resides in the Kidneys but influences the entire body’s functions, particularly the reproductive system and growth.
* **Clinical Significance**: Deficient Jing Qi may result in developmental delays, infertility, or premature aging.

**9. Qing Qi (清气) – Clean Air Qi**

* **Origin**: Qing Qi is the energy derived from the air we breathe. It is taken in by the Lungs.
* **Function**: Qing Qi supports respiration and works in conjunction with Gu Qi to form Zong Qi.
* **Pathway**: Qing Qi is absorbed by the Lungs and circulated in combination with other forms of Qi.
* **Clinical Significance**: Poor quality of Qing Qi, such as exposure to polluted air, can affect lung health and energy levels.

**10. Xie Qi (邪气) – Pathogenic Qi**

* **Origin**: Xie Qi refers to harmful external pathogens (such as Wind, Cold, Heat, Dampness) that can invade the body.
* **Function**: Xie Qi disrupts the body’s harmony and may lead to disease if it overpowers the body’s defenses (Wei Qi).
* **Pathway**: Xie Qi can invade the body through the skin, respiratory tract, or digestive system.
* **Clinical Significance**: The presence of Xie Qi can manifest as symptoms of disease, such as fever, chills, or inflammation.

In TCM, Qi is vital for the body’s functioning and health. Each type of Qi plays a unique role in supporting bodily functions, from digestion to immunity, growth, and respiration. Proper balance and movement of these different types of Qi are critical to maintaining health, and imbalances or deficiencies can lead to various disease patterns. TCM treatments, such as acupuncture, herbs, and Qi Gong, often aim to regulate and restore the balance of Qi in the body.

**Qi pattern identification**

Qi pattern identification is fundamental in Traditional Chinese Medicine (TCM) for diagnosing and understanding various health conditions. Qi, translated as “vital energy” or “life force,” flows through the body and is essential for maintaining balance and health. When Qi becomes imbalanced, it manifests in different patterns that can lead to various symptoms and diseases:

* + 1. [Qi Deficiency (气虚, Qì Xū)](https://yosan.edu/what-is-qi/#deficiency)
    2. [Qi Sinking (气陷, Qì Xiàn)](https://yosan.edu/what-is-qi/#sinking)
    3. [Qi Stagnation (气滞, Qì Zhì)](https://yosan.edu/what-is-qi/#stagnation)
    4. [Rebellious or Counterflow Qi (逆气, Nì Qì)](https://yosan.edu/what-is-qi/#rebellious)

**Qi Deficiency (气虚, Qì Xū)**

Qi deficiency refers to a state where the body’s energy is insufficient to support normal physiological functions. This pattern can affect any organ but is most commonly associated with the Spleen, Lung, and Kidney.

**Common Causes:**

* Chronic illness
* Poor diet or malnutrition
* Overwork or excessive physical exertion
* Aging

**Symptoms:**

* Fatigue and weakness
* Shortness of breath, especially on exertion
* Spontaneous sweating
* Pale complexion
* Weak voice or reluctance to speak
* Poor appetite
* Loose stools
* Weak pulse

**Treatment Approach:**

* Tonifying Qi through acupuncture and herbal formulas.
* Dietary recommendations to strengthen the Spleen and Lung Qi, such as consuming warm, nourishing foods.

**Qi Sinking (气陷, Qì Xiàn)**

Qi sinking is a more severe form of Qi deficiency where the Qi lacks the strength to hold organs and tissues in their proper place. It is most often associated with Spleen Qi deficiency.

**Common Causes:**

* Prolonged Qi deficiency
* Chronic illness
* Prolonged standing or physical exertion

**Symptoms:**

* Sensation of heaviness or bearing down, particularly in the lower abdomen
* Organ prolapse (e.g., uterine prolapse, hemorrhoids)
* Chronic diarrhea or frequent, urgent bowel movements
* Dizziness
* Fatigue

**Treatment Approach:**

* Strengthening and raising Qi with herbal formulas that include herbs like Huang Qi (Astragalus) and Bu Zhong Yi Qi Tang.
* Acupuncture points to tonify Spleen Qi and raise the Yang Qi, such as DU20 (Baihui) and ST36 (Zusanli).

**Qi Stagnation (气滞, Qì Zhì)**

Qi stagnation occurs when the flow of Qi is obstructed, leading to localized or systemic symptoms. It is often associated with emotional stress or lifestyle factors that impede the smooth movement of Qi.

**Common Causes:**

* Emotional stress (anger, frustration, resentment)
* Sedentary lifestyle
* Poor diet
* Physical trauma

**Symptoms:**

* Distending or wandering pain (often in the chest, hypochondrium, or abdomen)
* Emotional symptoms such as irritability, mood swings, or depression
* Sensation of fullness or oppression in the chest
* Sighing frequently
* Irregular menstruation in women
* Wiry pulse

**Treatment Approach:**

* Promoting the movement of Qi using acupuncture points like LV3 (Taichong) and LI4 (Hegu).
* Herbal formulas such as Xiao Yao San to soothe the Liver and relieve Qi stagnation.
* Lifestyle modifications to reduce stress and promote physical activity.

**Rebellious or Counterflow Qi (逆气, Nì Qì)**

Rebellious Qi occurs when the normal direction of Qi flow is disrupted, often manifesting as Qi moving in the wrong direction. Each organ has a specific direction of Qi movement, and disruption in this movement leads to different symptoms.

**Common Causes:**

* Emotional disturbances
* Improper diet
* Pathogenic factors like wind or cold

**Symptoms by Organ:**

* **Lung Rebellious Qi:** Cough, asthma, shortness of breath (Qi moving upwards)
* **Stomach Rebellious Qi:** Nausea, vomiting, belching, acid reflux (Qi moving upwards instead of downwards)
* **Liver Rebellious Qi:** Headaches, dizziness, irritability (Liver Qi rising upwards)
* **Spleen Rebellious Qi:** Diarrhea, abdominal bloating (Qi failing to ascend)

**Treatment Approach:**

* Correcting the flow of Qi through acupuncture points specific to the affected organ.
* Herbal formulas that help direct Qi in its proper direction, such as Ban Xia Hou Po Tang for Stomach Qi rebellion.
* Dietary and lifestyle adjustments to avoid foods or activities that exacerbate the condition.

**Clinical Importance**

Correctly identifying and differentiating between these Qi patterns is crucial for developing an effective treatment strategy. Acupuncture, herbal medicine, dietary therapy, and lifestyle modifications are typically employed to restore the balance and smooth flow of Qi, ultimately aiming to resolve the underlying disharmony and alleviate symptoms. In TCM, the body is seen as a microsystem where each organ has its function and role.

The lungs and wei qi are both said to control the body’s surface. This diffusing function of the lungs assists the spread of wei qi. While the lungs spread it, the true genesis of wei qi lies in the middle burner. The lungs are responsible for te skin and teh process of breathing. When the lungs ‘ energy is balanced, wei qi is strong and the immune system can fight any external pathogens. If it is out of balance, then the body isd more open to the attack of pathogens such as bacteria and viruses. Symptoms of unbalanced lungs energy and weak wei qi include fever, chills, headaches, söre throat, runny nose and coughing.

What damages wei qi:

Poor food choices (sugars, processed foods, fast foods, unhealthy snacks, processed meats, sugary drinks, alcohol)

Drugs, toxic substances and smoking

Sedentary lifestyle

Poor sleep patterns lead to mental confusion and lack of focus

Chronic or acute illnesses, immobility

Emotional stress such as fear , anger, irritability, anxiety, depression, grief, worry, guilt, blame, arrogance

Low sel esteem and lack of confidence

İnadequate home environment and contact with negative people

Environmental factors such as high pollution areas, excessive exposure to cold, wind and heat

The lungs are store house of fluid for the body.

The liver regulates qi activities

The heart manages the blood and comamnds the mental activity.

The kidneys store teh essence (jing) and dominates the reproduction and development

The stomach digests the foods and drinks, emotions, thoughts, nurturing the spirit

The spleen is in charge of digestion, blood coagulation and fluid metabolism

When a pathogen enters the body, the body temperature increases, Wei*Qi* is Yang (warm, energetic) in nature. Defensive *Qi* works mainly around the skin and muscles and includes fever, chills, and shivering responses. The stronger one’s immune system, the higher the fever and the worse symptoms. The defence mechanism helps the body into homeostasis. Sweating during a fever is seen in TCM as the body’s way of expelling the pathogen, with the pores letting the pathogen out. It is why TCM doctors will encourage a fever rather than suppress it. When the Wei Qi is weak, the pores and bodies are more open to an attack from the pathogens.

E**xercise** daily to the point of sweat expells the pathogens from entering the body barriers such as the skin. Meihua Quan is a combination of Yin and Yang. The balance between Yin activities (Qigong, Taiji, Meditation and breathing) and Yang activities (Shaolin, aerobic exercises, Wing Chun, Sanda) is ideal.

**Proper Sleeping Routine**: Sleep (at least 8 hours) is a rejuvenation time for the liver to replenish and cleanse the blood, build strong immunity, dream, rest, and restore.

**Cleansing regimen:** autumn is the season for organizing and letting go , an ideal time for cleansing the body of junk and negative emotions. Night is essential for preventing disease

**Proper nutrition :** Add to the diet foods such as chestnuts, raw onions, asian pears, apples, garlic, ginger, cardamom, cinnamon, clove, nutmeg, mint, mushrooms, parsnips, green onion, congee rice, banana, almond, white sesame and broccoli to help wei qi to get rid of pathogens

**Herbs :** Any herb or herbs combination thsat boosts or enhances the immune system would keep the body functionning at itsoptimal level. Astralagus (Huang qi) is used to tonify wei qi, fortify the lungs, protect against pathogens and increase the White blood cells count. Tonifying (strengthening) the protective qi ,the astralagus benefits digestion and reduces inflamation. Its gentle upward action lightens the body and limbs, helps to feel more energetic and less fatigued, and lifts the mind improving focus and memory. Astralagus is considered antihypertensive, hematopoetic, hepatoprotective, metabolic, anti-ageing,Cordyceps (Dong Chong Xia Cao) enhances the immunity by increasing White blood cells, T cells and interferon , inhibiting the growth of cancer cells.

**Acupuncture :** strenghtens the immunity by dispersing the lung and large intestine stagnation and clearing pathogens before going deeper into the body and enhances the circulation of energy and blood. Regular acupuncture treatments induces the body’s immune response by sending the increased T cells and White cells which are responsible for destroying pathogens , to the acupuncture sites to fight off the pathogens. Acupoint combinations for tonifying wei qi always include needles or moxa on ST 36, LI4, UB12 and 13. The traditional vegetative biofeedback therapy In Chinese medicine, considers the existence of a differential external protective field known as Wei Qi, which acts on the physical, emotional, and spiritual levels. The hypothetical existence of such a complex and dynamic biologic field within and around the body, which is involved in homeostasis, must be based on the electromagnetic field on acoustic and thermal related effects, and other subtle energy fields, which generate physical changes that are measurable with current technological methods. (147-148).

**“distant healing intention” (DHI) therapies**

Some practices act in a manner described as nonlocal, at a distance, compromising consciousness or transpersonal realities, transcendental or spiritual experiences,. The first approach to study these phenomena is to find the correlation with physical aspects such as light, electricity, heat, sound, and magnetism, which are measured using a wide variety of instruments and methods, including magnetometers, voltmeters, photometers, gamma radiation counters, sound equipment, and gas discharge visualization, among others because the use of proper and reliable instrumentation is a key factor to both document the phenomena and potentially calibrate. Within this field of study, intention, which could be defined as a directed thought to elicit a certain response, plays an important role in the process. Research has shown that an intended thought appears to be able to generate physical effects over inanimate objects and living things, from unicellular organisms to human beings. The nonlocality feature of this phenomenon is associated with the concept of entanglement and aspects of consciousness and quantum physics in which mental processes are referred to as a triggering element. (149)

In the case of distant healing, the healer directs his/her thought or intent to the patient even while physically separated. The concept of entanglement is used to describe a connection between two elements that exist even though separated across space. This phenomenon has obvious implications and requires not only clinical and preclinical studies in humans but also proper research with objective models exempt from expectation, belief, and psychosocial factors, such as models using animals, plants, biomolecules, tissue samples, and cell cultures.

DHI may be defined as a compassionate mental act directed toward the health and wellbeing of a distant person. DHI techniques are known by many names, including intercessory prayer, spiritual healing, aura healing, energy healing, energy psychology, shamanic healing, nonlocal healing, therapeutic touch (TT), quantum-touch, qigong, reconnective healing, Johrei, and Reiki. Each of these methods carries its own idiosyncratic theoretical and cultural forms, and some DHI methods include both distant and proximal (but without direct contact) variations. A common feature shared among DHI techniques is the assumption that distance between the healer and healee is not a limiting factor.

Given the well-accepted evidence for quantum nonlocality, which demonstrates the existence of “spooky action at a distance” , and especially the growing evidence for quantum coherence effects in living systems,possible physical mechanisms for DHI are no longer inconceivable.

The proof-of-principle question has been examined through 3 classes of experiments:

(1) mind-to-mind connections,

(2) direct interactions between mind and matter, and

(3) laboratory analogs of DHI, known as experiments on “distant mental interactions with living systems” or DMILS.

Hundreds of experiments in these 3 classes have been published and meta-analyzed.

The category of experiments that are most closely related to DHI phenomena are the DMILS studies. Three variants of DMILS protocols have been conducted:

(1) studies investigating the influence of A's intention on B's physiological state, referred to as “remote intention” experiments;

(2) studies investigating the influence of A's attention on B's physiological state while A gazes at B over a 1-way video link, also called “remote staring” experiments; and

(3) studies investigating the influence of A's intention on B's attention or behavior, known as “remote helping” experiments.

Physiological variables studied in DMILS experiments have included electrodermal activity, heart rate, blood volume pulse, electrocortical activity (via electroencephalogram [EEG]), and brain blood oxygenation (via functional magnetic resonance imaging [fMRI]), as well as studies from functional near-infrared spectroscopy (fNIRS) and electrogastrogram.But the proof-of-principle offered by DMILS experiments more clearly indicates the existence of genuine interactions between distant people. (150-151)

**Pranic healing (PH)**

Pranic healing refers to an alternative therapy that involves using the body’s energy to heal physical and emotional ailments. This non-touch therapy involves techniques for cleansing blockages in the energy system and re-energizing the body. Pranic healing works by detecting and manipulating the body’s energy fields to facilitate healing. Practitioners utilize specific techniques to cleanse stagnant or blocked energy, which allows for a smoother flow of energy throughout the body.Pranic healing is a holistic energy treatment method developed by Master Choa Kok Sui that focuses on harnessing the life force, known as “prana,” to promote physical and emotional healing without the need for physical contact.

This technique is rooted in the understanding that the human aura and energy fields surrounding the body can become imbalanced or blocked due to stress, trauma, or illness, leading to various health issues. By employing no-touch technology, practitioners cleanse these blockages and re-energize the affected areas to restore balance and health.Historically, pranic healing draws from ancient esoteric sciences and incorporates elements from various cultures, including Chinese medicine and Hindu practices, emphasizing the significance of energy flow in the body. Master Choa Kok Sui synthesized these teachings into a structured system that is both accessible and practical for modern practitioners. This no-drug healing therapy presents an approach to health care, highlighting the power of the body’s innate ability to heal through energy balancing.

The healing process of pranic healing involves a systematic approach to cleansing and energizing the body’s energy fields, utilizing techniques that focus on the manipulation of vital energy, or prana. Practitioners begin by scanning the aura to identify areas of blockages or depletion in life force energy employing various techniques such as sweeping, which involves removing negative or stagnant energy, and energizing, where fresh prana is directed to promote healing. The main principles of pranic healing are based on the understanding that the body has an inner healing ability and can restore itself when the energy flow is balanced. Research indicates that pranic healing is effective for a range of physical and emotional ailments.

During a session, the practitioner creates a clean energy environment, allowing the client to experience deep relaxation and enhanced awareness. The duration of healing after pranic therapy varies depending on individual circumstances, but many individuals experience progressive healing within a few sessions as the body begins to utilize the re-energized life force effectively. These techniques collectively establish pranic healing as a recognized energy healing modality, focusing on the holistic restoration of health through energy balancing. The advantages of pranic healing include accelerated healing, stress management, emotional clarity, and improved physical health enhancing the body’s natural ability to heal itself by balancing vital energy, which can lead to quicker recovery times. The following are the advantages of pranic healing:

* **Accelerated healing:** Accelerated healing refers to the process of recovery from physical and emotional ailments at a faster rate than traditional healing methods. Prana helps accelerate healing by enhancing the body’s natural healing processes. It facilitates the cleansing of energy blockages and promotes the flow of vital energy, allowing the body to heal more efficiently. Individuals experience quicker recovery from injuries, reduced healing times for surgical wounds, and overall improved physical health.
* **Stress management:** Stress management involves utilizing pranic healing techniques to balance energy fields and promote relaxation, reducing stress responses. Prana assists in stress management by balancing energy fields and promoting relaxation through energy-healing techniques. This helps reduce the body’s stress response and enhances emotional well-being. Individuals experience lower anxiety levels, improved mood, and a greater sense of calm and clarity.
* **Emotional clarity:** Emotional clarity is the improved understanding and management of one’s emotions achieved through cleansing emotional blockages with pranic healing. Prana enhances emotional clarity by helping individuals cleanse their emotional blockages and promote balance within their energy systems. This leads to a better understanding of one’s emotional states and improved emotional responses.
* **Pain relief:** Pain relief is the reduction of discomfort and inflammation through the application of healing energy to affected areas. Prana facilitates pain relief by channeling healing energy to affected areas. It helps reduce inflammation and promote relaxation of muscles and tissues.
* **Improved physical health:** Improved physical health signifies better overall wellness and resilience against illnesses as a result of optimized energy flow in the body. Prana supports overall physical health by enhancing the body’s energy levels and promoting optimal functioning of the immune system. This holistic approach helps individuals maintain better health and resilience against illnesses.
* **Better sleep:** Better sleep refers to enhanced sleep quality and reduced disturbances achieved through relaxation techniques provided by pranic healing. Prana aids in better sleep by promoting relaxation and reducing anxiety, allowing individuals to achieve restful sleep patterns. By balancing energy within the body, pranic healing helps alleviate insomnia and other sleep disturbances.
* **Preventive healthcare:** Preventive healthcare is the proactive maintenance of health and prevention of illness facilitated by regular pranic healing sessions. Prana serves as a form of preventive healthcare by maintaining energy balance and promoting overall wellness, which reduces the likelihood of illness. Regular pranic healing sessions help identify and address energy imbalances before they manifest as physical ailments.
* **Balanced chakras:** Balanced chakras are the optimal alignment and flow of energy through the body’s energy centers, promoting physical and emotional well-being. Prana works to balance chakras, the energy centers in the body, facilitating optimal energy flow and promoting emotional and physical well-being. When chakras are balanced, individuals experience enhanced mood, better health, and increased energy levels.
* **Spiritual growth:** Spiritual growth is the deepening of self-awareness and personal insight gained through the practices of pranic healing. Prana encourages spiritual growth by fostering a deeper connection with oneself and the surrounding environment. Through pranic healing, individuals experience heightened awareness, improved intuition, and a greater sense of purpose.
* **Emotional healing:** Emotional healing is the process of releasing negative energy associated with past traumas, leading to improved emotional health. Prana promotes emotional healing by addressing unresolved emotional traumas and helping individuals release negative energy patterns. This process can lead to improved emotional health and resilience.
* **Treatment of addictions:** Treatment of addictions involves utilizing pranic healing as a supportive therapy to help individuals release negative energy patterns related to addictive behaviors. Prana is utilized as an adjunctive therapy for treating addictions by helping individuals release negative energy associated with addictive behaviors and fostering inner healing. This holistic approach supports traditional addiction treatment modalities.

**PRANIC HEALING LEVELS**

* **Pranic Healing Level I: Basic Pranic Healing:**This foundational level covers the basic principles of pranic healing, including how to feel and manipulate the energy of the human aura. It is designed for beginners, including individuals interested in holistic health and healing. Key techniques taught include energy scanning, cleansing, and energizing, allowing practitioners to address minor physical ailments. This level enhances skills by providing a solid grounding in energy awareness and techniques.
* **Pranic Healing Level II: Advanced Pranic Healing:** This level introduces more advanced techniques for dealing with serious physical and psychological conditions, including the use of color pranas. It is intended for practitioners who have completed Level I and wish to deepen their understanding of pranic healing. Key techniques taught include advanced energy manipulation, treatment of chronic diseases, and the application of color energy for targeted healing. This level enhances skills by training practitioners to use more complex techniques, leading to improved healing outcomes.
* **Pranic Healing Level III: Pranic Psychotherapy:** Level III focuses on the emotional and psychological aspects of healing, teaching practitioners how to address mental health issues through energy work. It is aimed at individuals who have completed Levels I and II and are interested in applying pranic healing to psychological conditions. Key techniques include emotional cleansing, psychic self-defense, and energy balancing for mental stability. This level enhances skills by equipping practitioners with tools to address emotional blockages and improve mental well-being.
* **Pranic Healing Level IV: Pranic Crystal Healing:** This advanced level explores the use of crystals in pranic healing, teaching practitioners how to enhance their healing techniques with crystal energy. It is suitable for those who have completed the previous levels and wish to incorporate crystals into their practice. Key techniques taught include the selection and programming of crystals for specific healing purposes. This level enhances skills by providing a unique approach to energy healing, combining the properties of crystals with pranic techniques.

**What are the Guidelines for Pranic Healing?**

The guidelines for performing pranic healing include adequate training and maintaining a safe and clean environment. These guidelines are essential to ensure effective treatment and maintain the integrity of the healing process. Practitioners must be adequately trained and certified in pranic healing techniques to ensure they are knowledgeable about the process and capable of addressing various conditions. Creating a clean and safe environment for the healing session, free from distractions and negative influences, is crucial. Pranic healing supports drug abuse screening tests by addressing underlying emotional and energetic imbalances. Pranic healing can complement traditional therapeutic approaches, potentially enhancing an individual’s motivation to engage in recovery and reducing withdrawal symptoms.

Most modern practitioners of Pranic Healing use a version that was formalized in the Philippines and includes elements from Chinese Traditional Medicine. Pranic Healers work with the layers of the subtle energy ﬁ eld that surrounds the physical body. Based on the premise that the bioﬁeld is a mold or template the physical body follows, the Pranic Healing practitioner begins to scan the bioﬁeld with his/her hands for areas of congestion or depletion of subtle energy that correspond to the presenting problem (whether physical or psychological). After having located and identiﬁed areas of concern, the practitioner sweeps the bioﬁeld with his/her hands in order to clean out the congestion, redistribute prana, and seal any holes in the ﬁeld, so the affected areas of speciﬁ c health concerns are treated locally via speciﬁ c manual cleansing movements. The bioﬁeld is completely cleansed as determined by rescanning, the ﬁnal stage begins which involves energizing the affected areas with fresh prana that is drawn from the atmosphere and projected on to impacted areas. (152-153).

**The Meditation on Twin Hearts (MTH)**

The Meditation on Twin Hearts (MTH) is a core meditation in both Pranic Healing and modern Arhatic Yoga practices. This guided meditation, which can be defined as “a systematic mental training designed to challenge habits of attending, thinking, perceiving, and feeling.”, includes components of lovingkindness, open awareness, and self-healing imagery.The P300 wave is an electrical response of the brain to a unique stimuli. It is measured through electroencephalography (EEG) and is described in terms of amplitude (the strength of the wave) and latency (the speed of the wave). The P300 wave response is a measure of cognitive about the brain’s ability to distinguish a novel stimuli (amplitude) as well as how quickly or easily this process happens (latency). The average latency to make a discrimination between a standard and unique stimulus is 300 ms.

In persons with decreased cognitive ability, the P300 tends to be smaller, with longer latency, whereas shorter P300 peak latencies have been associated with better cognitive performance on tests of attention and immediate memory. The P300 response is considered a good measure of cognition. Because the P300 wave is only present when the subject is actively engaged in an attention task designed to notice target stimuli. This response is measured using an “oddball” paradigm, where the subject is exposed to a series of identical stimuli (ie, auditory tones), which are intermittently interrupted by a novel stimuli. (154)

# **Hydrotherapy and the healing power of water**

Accordingly, water, as the main component of the human body, stands as an obvious choice not only to avoid the aforemen tioned interactions but also to generate hypotheses to explicate the subsequent effects and relationships within complex biological systems. Water has been used as a model in several studies with outcomes that suggest some of its properties, such as the cooling rate, the molecular bonding as reflected by changes in the infrared spectra, the vibrational state as measured by Raman spectroscopy, scattered laser light, and the pH level, may be affected by intention.

**Benefits of Aqua Therapy**

Improving flexibility

Reducing pain and compression in joints

Enhancing muscle strength and stability

Improving balance and coordination

Reducing stress by promoting muscle relaxation

Correcting gait posture

Enhancing aerobic capacity

Increasing range of motion

Improving respiration and circulation

Compared to conventional physiotherapy, aqua therapy results in less pain during the recovery process. Further, water-based treatment facilitates healing as quickly as possible.

Aqua therapy can be administered across age groups and for different physiological conditions:

Skin infection or wound

Stomach upset or viral infection

Breathing difficulties

Heart problems

Kidney issues that require dialysis

Chlorine allergy

Diabetes, epilepsy, asthma

Loss of bladder control

Higher body temperature

**Types of Aqua Therapy**

**Aquatic Therapy Exercises**

There are various aquatic therapy exercises, including warm-up exercises, fitness and strength training, core training, and cool-down exercises, are conducted in an aquatic environment. Warm-ups involve low-resistance exercises (stretches, jogging, extensions) that target the lower and upper extremities of the body. Post-warm-up, fitness, and strength training exercises are administered. This involves cardiovascular activities, plyometrics, or multi-planar activities. The final stage of core training and cool-down exercises works on muscles to prevent lactic acid build-up.

**Spas**

Spa therapy or balneotherapy refers to hydrotherapy without exercise. It uses natural hot springs, mineral or seawater, and mud to reduce pain and soreness. In addition, the thermal mineral water helps promote circulation and relaxation and stimulates the immune system. The treatment is administered through various techniques, including alternating between cold and hot and partial baths.

**Hydro-massage**

The use of pressurized jets that can be adjusted based on personal preferences, to massage muscles and soft tissues in the body is hydro-massage. In the dry hydro-massage, there is no direct contact with water,just laying down on a water-filled mattress with jets. In addition to regulating pressure, these mattresses have the added benefit of controlling temperature.

**Kneipp System**

The Kneipp system, known as Kneipping, named after Father Sebastian Kneipp, involves using herbal and mineral baths of varying temperatures. The technique promotes circulation, strengthens the immune system, and improves the nervous system. Along with basic water-based therapy, barefoot walking and walking on pebbles, wraps, rinses, and baths are also administered.

# Some of the SHA hydrotherapy treatments:

# **Watsu: relaxes the body and improves digestion.**

# A therapy that combines gentle stretching movements with oriental acupuncture techniques and shiatsu massage,decompresses the spine, mobilises joints and stretches muscles without impact.It is Ideal for relaxing the body, improving digestion and eliminating the effects of jet lag.

* + 1. **Aquasonotherapy: a regenerating massage**

Treatment based on the direct link between the different parts of the body and certain sounds, aims to break, dissolve and eliminate blockages, while harmonising the body’s vibration. A soothing and regenerating massage is performed using sound waves and water, creating sensations that facilitate the movement of energy through the cell membrane.

1. **Craniocervical water therapy: unblock tensions.**

Holistic therapy is ideal for calming the mind. It releases tension in the head, neck, shoulders and jaw while removing energy blockages and relieves migraines, insomnia and neck pain.Designed to release contractions and restrictions in connective tissues, it improves functional alignment, facilitating the body’s self-corrective mechanisms.It is especially recommended to relieve craniofacial pain, migraines and chronic and acute neck or back pain, bruxism and cases of insomnia, fatigue, stress, fibromyalgia, scoliosis, discopathies, etc.

**4.Body drainage: stimulates the lymphatic system**

This treatment stimulates the lymphatic system through a targeted massage using sea-based ingredients. The lymphatic system works together with the kidneys and liver to eliminate toxins and waste from the body. However, it does not have a natural pumping system like the heart, so it needs extra support to function properly. This treatment aims to stimulate the lymphatic system through a localised massage. Immediately there is an improvement in the liver and abdomen, as well as a feeling of lightness.

* + 1. **Hydroenergetic detox cure: revitalises the body**

A powerful purifying and energising treatment consists of three steps: hydromassage bath, phytopharmacotherapy and hydrojet. It soothes and purifies while draining, detoxifying and revitalising the body before restoring energy, vitality and tone.

* + 1. **Underwater therapy: anti-ageing**

In this invigorating and therapeutic treatment, Pressurised hot water is applied by jet.The action of the water eliminates swelling due to lymphatic blockage by promoting blood and lymphatic circulation, combats cellulite, restores skin elasticity and tone, improves cell metabolism, helps burn fat and reduces oxidation for anti-ageing results.

Aqua therapy or hydrotherapy is any exercise performed in water to facilitate recovery. The principles of aqua therapy have been practiced since the Roman civilizations. People would bathe in hot springs to reduce chronic pain, menstrual issues, skin problems, and more. Aqua therapy is different from aquatic therapy exercises and aquatic fitness as it involves physical medicine and rehabilitation.

**Conditions Treated with Aqua Therapy**

Research suggests that pressurized jets and other equipment help release tension, soreness, and pain.

Pain

Sprain and strain

Arthritis

Fibromyalgia

Orthopedic injuries

Sciatica

Post-surgical pain

Gait and posture issues

Stress

Balance issues

Neurological disorders

Multiple sclerosis

Spondylitis

Autism spectrum disorders

Stroke

Traumatic brain injuries

Spinal cord injury

**Aquatic Therapy Equipment**

For rehabilitation or outpatient consultation, various equipment can be used, including

Underwater treadmills

Stationary bicycles

Buoyant belts

Flotation rings

Dumbbells or barbells

Wrist weights

Ankle weights

Resistance bands and tubing

Short-tipped flippers and fins

Resistance handbells and paddles

Aquatic paddles

Noodle

Kickboards

Resistance gloves

Foam collars

Water current

Jets

Aquatic paddles

Stairs and steps

These equipment are used in combination with other treatment modalities to facilitate smooth recovery.

# While aqua therapy is effective at treating different physiological conditions, it also provides a feeling of rejuvenation and calmness. [Hydrotherapy](https://www.hydroworx.com/blog/hydrotherapy-101-understanding-the-basics-and-benefits/) offers therapeutic benefits that extend beyond physical well-being. The healing properties of water have long been revered for their calming effects, making aquatic therapy a promising avenue for addressing mental health challenges. Beyond the moisturising power, water, that possesses healing properties, is used as a therapeutic agent. Hydrotherapy uses water—both internally and externally and at different temperatures—to positively influencing health and well-being.

The calming effects of water offer a sanctuary for relaxation and mental rejuvenation. Immersing oneself in a therapy pool creates a tranquil environment that promotes inner peace and serenity. The gentle embrace of water alleviates stress, anxiety, and tension, providing a soothing respite from the demands of daily life. The buoyancy and warmth of water create a therapeutic oasis where individuals can unwind and disconnect from the outside world.

The rhythmic movements of water can lull the mind into a state of tranquility, fostering a sense of calm and emotional balance. [Research](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4049052/) has shown that water therapy can reduce levels of cortisol, the stress hormone, leading to a decrease in overall stress and promoting mental well-being. By submerging in water, individuals can experience a sense of weightlessness and freedom, allowing them to release mental burdens and find solace in the healing embrace of water. Whether through gentle floating or immersive aquatic exercises, the calming effects of water provide a holistic approach to mental health and wellness. Aquatic exercise offers an avenue for [mood enhancement](https://www.hydroworx.com/blog/increase-patient-morale-aquatic-therapy/) and mental well-being, harnessing the therapeutic benefits of water to uplift spirits and promote emotional balance. Engaging in water-based activities in a therapy pool can have a significant impact on mood by releasing endorphins, the body’s natural mood elevators.

The buoyancy of water reduces the impact on joints, making aquatic exercise gentle yet effective for individuals of all fitness levels. Immersed in water, individuals experience a sense of weightlessness that enhances mobility and allows for fluid, unrestricted movements that can boost mood and alleviate feelings of heaviness or tension. From [aquatic walking](https://www.hydroworx.com/blog/underwater-treadmill-walking-vs-shallow-water-walking-benefits-rehabilitation/) to [hydrotherapy strength training](https://www.hydroworx.com/blog/aquatic-interval-training-optimizing-workouts-for-athletic-performance/), the variety of exercises available in a therapy pool caters to diverse needs and preferences, offering a holistic approach to mental wellness.The serene environment of a therapy pool creates a peaceful backdrop for physical activity, encouraging relaxation and mindfulness during aquatic exercise sessions. The combination of movement, water resistance, and sensory stimulation creates a dynamic and engaging workout experience that energizes the body and uplifts the spirit. By incorporating aquatic exercise into a mental health regimen, individuals can experience the transformative power of water in enhancing mood, promoting emotional well-being, and fostering a positive outlook on life.

The mental benefits of hydrotherapy:

Stress reduction

Mood enhancement

Emotional healing

Cognitive stimulation

relaxation

**Cognitive Benefits of Hydrotherapy**

Hydrotherapy stimulates cognitive function and enhances mental agility through engaging water-based activities.

* **Improved Focus and Memory:**The sensory experience of water immersion can help individuals enhance their focus, concentration, and [**memory retention**](https://www.hydroworx.com/research-education/additional-resources/alzheimers-and-aquatic-therapy/).
* **Mental Clarity:**The tranquil environment of a therapy pool provides a calming space for individuals to clear their minds, improve mental clarity, and enhance cognitive processing.
* **Stimulation of Neural Pathways:**Water-based exercises challenge the brain to coordinate movements in a different environment, promoting the development of neural pathways and cognitive skills.
* **Multi-Sensory Engagement:**Hydrotherapy engages multiple senses simultaneously, promoting sensory integration and cognitive development through tactile, proprioceptive, and vestibular stimulation.
* **Emotional Regulation:**The therapeutic effects of water can aid in emotional regulation and mood management, supporting cognitive functions related to decision-making, problem-solving, and emotional processing.
* **Neuroplasticity:** By engaging in water-based activities that challenge the brain and body, individuals can support [**neuroplasticity**](https://www.hydroworx.com/customer-resources/webinar-and-events/course-1-stroke-rehabilitation-neurosplashticity/), the brain’s ability to reorganize and form new connections, enhancing cognitive flexibility and resilience.

**Emotional Healing and Support**

Emotional healing and support are fundamental aspects of hydrotherapy, offering individuals a nurturing space to address trauma, grief, and emotional distress. Through the power of water, hydrotherapy facilitates emotional healing on multiple levels, fostering a sense of comfort, acceptance, and resilience.

* **Safe Emotional Outlet:**Therapy pools provide a safe and gentle environment where individuals can release pent-up emotions and express themselves freely without judgment. The buoyancy of water offers a supportive medium for emotional exploration and processing.
* **Stress Relief:**Immersion in water can reduce feelings of stress and anxiety, promoting relaxation and emotional well-being. The calming properties of water soothe the mind and body, creating a peaceful refuge for emotional healing.
* **Healing Touch:**Water’s tactile stimulation and gentle pressure can have a comforting and therapeutic effect on emotional wounds, promoting a sense of security and inner peace. The supportive nature of water envelops individuals in a soothing embrace, fostering a deep sense of emotional connection and healing.
* **Mind-Body Connection:**Hydrotherapy encourages individuals to reconnect with their bodies and emotions, promoting mindfulness and self-awareness. By engaging in water-based activities, individuals can cultivate a sense of harmony between their physical and emotional states, facilitating emotional healing and personal growth.

Life begins in water from birth, significant energy is spent balancing the pull of gravity, particularly in the musculoskeletal and connective tissue systems. A water-based environment transiently liberates the body from the adverse effects of gravity. In the water, energy normally needed to resist gravity and maintain the human form in an upright, mobile, and functional position is transferred to tissue repair and regeneration in the setting of injury or rehabilitation.

The use of water for therapeutic purposes has origins dating back to ancient Egyptian, Greek, and Roman civilizations and encompasses a broad array of applications from supportive to therapeutic, and from recreational to rehabilitative. Hydrotherapy and water therapy both take advantage of the physical properties of water; however, the two approaches are very different. Hydrotherapy, a supportive, passive, adjunctive treatment used in nursing and therapy, refers to immersion of the body in a whirlpool or bath in an effort to use the properties of water, including temperature and pressure, to passively improve circulation and provide stress or pain relief. An example is WATSU (Water Shiatsu), which involves the use of passive stretch and massage techniques, including palpation of acupressure points, performed in warm water.

Water therapy, on the other hand, is an active form of physical and recreational therapy that engages the physical properties of water, including buoyancy, resistance, and hydrostatic pressure, to train and condition, actively rehabilitate injuries, and maintain health. This occurs by facilitating relaxation, decreasing restriction of movement, and unloading joints. One water therapy method seen both in practice and literature is the Halliwick Method,( also known as the Ten Point Program ) first described in 1981, primarily involves active techniques to increase stability and postural control and facilitate movement through sensory input and fluid mechanics imparted by water.

In neurological injuries such as spinal cord injury, positive findings such as improved physical function, physical fitness, and mobility, have shown that therapeutic water exercise is a safe and efficacious modality for chronic musculoskeletal pathology such as low back pain include. By naturally offloading pressure from joints, water provides an optimal environment to exercise aerobically and at greater intensities than would be possible on land. Water can also promote the body’s innate ability to heal itself. In fibromyalgia, improvements were demonstrated in quality of life, stiffness, cardiovascular function, muscle strength, depression, anxiety, and sleep. Multiple studies have shown positive outcomes related to exercise performance, body composition, skeletal muscle strength, and respiratory function. In older adults, water- based exercise is as effective as land-based exercise in improving physical functioning, with statistically significant improvements in muscular strength and endurance, balance, flexibility, and aerobic capacity.

A program focusing on the principle of fitness intelligence, is founded on the following tenets: exercise is performed in both shallow and deep water in the vertical position;

exercise changes starting positions in regards to postural control and multidirectional stability; exercise is practiced at different speeds (slow, medium, fast);

exercise is performed in multiple directions (forward, backwards, laterally) and includes navigating turns, jumping, and landing;

exercise pays close attention to body alignment;

exercise involved in the rehabilitation, conditioning, and/or training process, can be choreographed to become a personalized routine that can be continued outside of the therapy setting.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC7056478/table/t1-jer-16-1-20/>

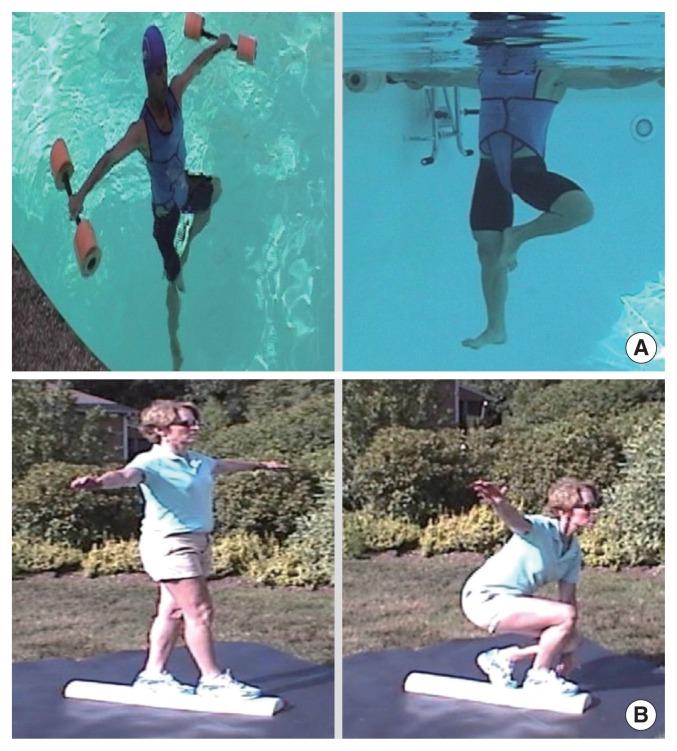
One of the properties conferred by water is buoyancy., the upward, anti-gravity force of the density of a fluid acting on an immersed object while holding it up. The pressure counteracts the downward force of gravity, and relieves the body from compression and pain. The deeper into water, the less pressure is exerted by gravity. Gravitational force is reduced by 30% at knee-level and 50% at waist-level, and at the neck weight bearing is reduced of approximately 90% . By reducing pressure on the spine and other weight-bearing joints, buoyancy, combined with hydrostatic pressure, provides natural vertical traction that can decompress and provide mobility to previously stiff and painful joints.

It is important to stress that vertical position is functional position, both in water and on land. In the presence of pain or injury, the body develops poor posture, gait deviations, and decreased mobility. Beginning an exercise program in deep water in the vertical position is recommended, with the goal of promoting and restoring the body’s natural alignment. Maintaining one’s body in the vertical position in the water can lead to improved alignment and postural stability. The main goal is to engage in exercises that promote six essential qualities in the water and land: balance, coordination, flexibility, endurance, speed, and strength. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7056478/figure/f1-jer-16-1-20/>The first foundational quality is balance, that refers not just to balance required to stay upright while in the standing position, but also balance of the entire body and its systems. The second quality is coordination. Proper movement involves coordinated, controlled contraction and relaxation of the musculoskeletal system, while discoordination can predispose to stiffness and injury. The third quality is flexibility.

[](https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=7056478_jer-16-1-20f2.jpg)

<https://pmc.ncbi.nlm.nih.gov/articles/PMC7056478/figure/f2-jer-16-1-20/>

Fig.20. Examples of water exercise for the first foundational quality – balance.

[](https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=7056478_jer-16-1-20f3.jpg)

<https://pmc.ncbi.nlm.nih.gov/articles/PMC7056478/figure/f3-jer-16-1-20/> Fig.21. Examples of water (A) and land (B) exercises for the second foundational quality – coordination.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC7056478/figure/f4-jer-16-1-20/>Fourth is the quality of endurance, giving the ability to safely perform exercises for increasingly longer periods of time. Speed comprises the fifth quality, that focuses on the ability to effectively use the entire body and its individual parts while changing direction and velocity. The sixth quality is strength, which can be defined more as the ability to resist pressure in all directions in space, rather than power production alone. In this approach, strength training exercises involve controlling the center of gravity on land, and center of buoyancy in water, allowing to safely progress to resisting increasing loads on the human body and returning it to prior level of function.

As the body learns and practices the exercises, while employing the six essential qualities, the central nervous system also adapts and evolves, reflecting the strong positive relationship between physical exercise and central nervous system health. Exercise-induced improvements in learning and memory have been associated with increased neural synaptic plasticity and hippocampal volume, suggesting that exercise may improve brain function and slow decline of cognition with aging. In the short-term, challenging the body and mind to learn multidirectional stability, dynamic postural control, and varying degrees of gravity in the water prevents adaptation of the body to repetitive exercises. The aquatic environment has broad rehabilitative potential. Hydrotherapy is the external or internal use of water in any of its forms (water, ice, steam) for health promotion or treatment of various diseases with various temperatures, pressure, duration, and site. It is one of the naturopathic treatment modality used widely in ancient cultures including India, Egypt, China, etc. Superficial cold application may cause physiologic reactions such as decrease in local metabolic function, local edema, nerve conduction velocity (NCV), muscle spasm, and increase in local anesthetic effects.

Immersion at 20°C decreased plasma renin activity and cortisol concentrations while plasma aldosterone concentration was unchanged. Diuresis was increased by 89%. No significant differences in changes in plasma renin activity, aldosterone concentration, and diuresis compared with subjects immersed in 32°C. Immersion at 14°C increased plasma noradrenaline and dopamine concentrations by 530% and by 250%, respectively, while diuresis increased by 163%. Plasma aldosterone concentrations increased by 23%. Plasma renin activity was reduced. Cortisol concentrations tended to decrease. Plasma adrenaline concentrations remained unchanged. Regular winter swimming significantly decreased tension, fatigue, memory, and mood negative state points with the duration of swimming period; significantly increased vigor-activity scores; relieved pain who suffered from rheumatism, fibromyalgia, or asthma; and improved general well-being in swimmers. Cold exposure (CE) to small surface area produced compensatory vasodilatation in deeper vascular system resulting increased blood flow to the tissues underlying the site of exposure. This vascular reaction occurs mainly to maintain constant deep tissue temperature.

In patient with chronic heart failure (CHF), thermal vasodilatation following warm-water bathing and low-temperature sauna bathing (LTSB) at 60°C for 15 min improves cardiac function; repeated sauna-therapy (ST) increased left ventricular ejection fraction; increased 6-min walk distance in association with improvement in flow-mediated dilation and increase in number of circulating CD34 (+) cells; reduced plasma levels of norepinephrine and brain natriuretic peptide. These indicates that ST improves exercise tolerance in association with improvement in endothelial function and reduces level of total and low density lipoprotein (LDL)-cholesterol concentration, while increases level of high density lipoprotein (HDL)-cholesterol . These changes are good prognoses for the prevention of ischemic heart disease. ST increases endothelial nitric oxide synthase (eNOS) activity and improves cardiac function in heart failure and improve peripheral blood flow in ischemic limbs. LTSB improves peripheral circulation in cerebral palsy (CP). Cold water immersion (CWI) induces significant physiological and biochemical changes in the body such as increase in HR, BP, metabolism, and peripheral catecholamine concentration; and decrease in cerebral blood flow.

Hyperthermic immersion (HI) produced shortening of activated partial thromboplastin time. During HI plasminogen activator inhibitor (PAI) activity was decreased; thrombocyte count was increased; increases in tissue-type plasminogen activator concentration and leukocytes count were attributed to hemoconcentration. Immediately after HI, fibrinogen concentration decreased but increased during recovery. During thermo-neutral immersion prothrombin time, PAI activity and granulocyte count decreased. Warm water bathing leads to hemoconcentration and minimal activation of coagulation; decrease in PAI-1 activity. During contrast baths, longer duration in the second heating phase was required to produce sufficient fluctuation in blood flow.

Two main factors affecting O2 transport during immersion are temperature and hydrostatic pressure. O2 transport was improved above neutral temperature, because of increase in cardiac output resulting from the combined actions of hydrostatic counter pressure and body heating. Significant decrease in vital capacity (VC) with bath temperature was observed. Significant increase in tidal volume (VT) in cold or hot water compared with thermo neutral water. Alterations in respiratory muscles functioning produce variations of the pulmonary volumes as a function of water temperature. Repeated cold water stimulations reduced frequency of infections; increased peak expiratory flow, lymphocyte counts, and expression of gamma-interferon; modulated interleukin expression; and improved quality of life (QOL) in patients with chronic obstructive pulmonary disease.

Temperature and pressure of water in aquatic or hydrotherapy can block nociceptors by acting on thermal receptors and mechanoreceptors and exert positive effect on spinal segmental mechanisms, which is useful for painful condition. Ten minutes of immersions in whirlpools produced increases in pulse and finger temperature with increased feelings of well-being and decreased state anxiety. Adapted cold shower might have antipsychotic effect similar to that of electroconvulsive therapy because it could work as mild electroshock applied to sensory cortex. Cold shower is an example of stress-induced analgesia and would also be expected to “crowd out” or suppress psychosis-related neurotransmission within mesolimbic system. Walking in water at umbilical level increases the activity of erector spinae and activates rectus femoris to levels near to or higher than walking on dry ground.

Leg immersion in warm water (44 ± 1°C) for 45 min before stretch-shortening exercise reduced most of the indirect markers of exercise-induced muscle damage, including muscle soreness, creatine kinase activity in the blood, maximal voluntary contraction force, and jump height. Contrast water therapy (CWT) [alternating 1-min hot (38°C) and 1-min cold (15°C)] for 6/12/18 min lowered subjective measures of thermal sensation and muscle. Aqua-jogging without caloric restrictions in obese persons for 6 weeks was associated with reductions in waist circumference and body fat; improvement of aerobic fitness and QOL.

Water buoyancy reduces the weight that joints, bones, and muscles have to bear. Warmth and pressure of water also reduce swelling and reduces load on painful joints, remotes muscle relaxation. pain before and after walking. Drinking water significantly elevates the resting energy expenditure (REE) in adults but in overweight children transient decrease in REE was observed immediately after drinking 10 ml/kg cold water (4°C). Then a subsequent rise in REE was observed, which was significant after 24 min and the maximal mean REE values were seen after 57 min, which was 25% higher than baseline. The recommended daily amount of water consumption in children could result in energy expenditure equivalent to additional weight loss of about 1.2 kg/year suggesting that water drinking could assist overweight children in weight loss or maintenance.

Warm water is effective for colonic spasm in which significantly less discomfort was reported compared with control group and this may be useful. The higher is the bath temperature, the greater the drop in rectal neck pressure and internal sphincter electromyographic activity, and longer the time needed to return to pretest levels. Immersion in Dead Sea water produced significant reduction in blood glucose in type-2 diabetes mellitus (DM) . Warm water (28°C) treatment could not only cure bacterial cold-water disease but also immunize against causative agent *Flavobacterium psychrophilum*. Sauna (80°C) produced stable epidermal barrier function; increase in stratum corneum hydration; faster recovery of both elevated water loss and skin pH; decrease in casual skin sebum content on skin surface of forehead; increase in ionic concentration in sweat and epidermal blood perfusion in volunteers. Aquatic therapy, characterized by its use of the physical properties of water, offers advantages for the rehabilitation of musculoskeletal conditions by reducing joint stress, enhancing muscle relaxation, and facilitating easier movement compared to traditional land-based therapies. The buoyancy, viscosity, and hydrostatic pressure of water provide natural resistance and support, allowing for early intervention and safer exercise regimens for individuals with various musculoskeletal disorders.

The therapeutic methods of applying water mentioned can be divided into five categories: application by

(1) listening: When one is unable to fall asleep, the sound of water is used as a hypnotic agent. The idea is to let the patient count the dripping sounds of water; the technique apparently works as a sedative when one cannot sleep owing to uneasiness or worries, exhaustion or nightmares

(2) washing: Washing with Cold water was recommended to wash cuts, tired eyes, venereal ulcers and skin diseases.

(3) bathing in hot water, stimulates perspiration from two angles: it warms up the body from inside, and opens the pores of the skin.

(4) spitting, Spitting water over the face was considered an effective stimulant for a patient who had lost consciousness, a newborn infant who failed to cry, for infantile convulsions and post-partum bleeding or dizziness. For a weak newborn infant, the shock occasioned by spitting cold water may have been sufficient to cause him or her to give a first cry. Water had a cooling effect. Convulsions and dizziness occured due to ‘sashikomi 衝逆 (the retrograde upward movement of ki)’, which can be treated by cooling. Uterine bleeding involved such symptoms as ‘fever, perspiration and palpitations’ which were categorised as ‘hot’ in nature; thus cooling would relieve the symptoms.

(5) Imbibing Drinking cold water had a cooling effect for various pains that occured in the inner organs. It was apparently effective for kakuran 霍乱 (severe vomiting and diarrhoea), food poisoning, and pain caused by threadworms or pinworms. Drinking water cool the inner organs. Tthe cooling effect of water is related to detoxification. Tthe use of water for food poisoning is designed to be a cooling antidote.

(6) soaking and immersion.

Using this method, the patient is soaked or pumped with cold water, placed under a waterfall, bathed in a well or immersed and made to swim in a river. The coldness of the water and the stimulation from pumping were thought to have an energising effect on the body. The intention seems to have been to stimulate numb limbs or strengthen a weak infant. It is possible to consider the efficacy of water from the viewpoint of yin and yang differentiation. In traditional diagnosis, symptoms are largely divided into the two categories of yin and yang. Formun Altı

Yin symptoms are associated with the inside, of the body, depletion, coldness, the downward movement of ki, chronic illness, languor, inhibition, decline in bodily metabolism or body function, and so forth. On the other hand, yang symptoms are identified with the outside, repletion, heat, the upward movement of ki, acceleration in bodily metabolism and function, acute illness, exuberance, and exhalation. Being innately yin, water would be pumped on to people with yang symptoms, thereby combating the disease. In the matter of cure the power of water achieves a balance between the two attributes, curing the illness. ‘Heat’ is the most obvious case of a yang symptom.

(7) Affusion therapy, is the controlled application of water to specific parts of the body for therapeutic purposes. It’s like giving to the body a targeted shower of healing like standing under a waterfall, feeling the rush of water cascading and washing away tension and stress. The word “affusion” comes from the Latin “affundere,” meaning “to pour on.” Unlike full-body immersion therapies, affusion allows for targeted treatment of specific body areas. It’s like the sniper of the hydrotherapy world – precise, focused, and highly effective.

When water comes into contact with the skin, it triggers a cascade of physiological responses. The temperature of the water plays a crucial role. Cold water causes blood vessels to constrict, pushing blood towards the core of the body. This can help reduce inflammation and swelling. On the flip side, warm water dilates blood vessels, increasing blood flow to the skin and muscles. This can help relax tense muscles and ease pain.

The pressure of the water also matters. The gentle pressure of affusion can stimulate nerve endings in the skin, sending signals to the brain that can help reduce pain perception and promote relaxation. It’s like a gentle massage from Mother Nature herself.The stimulation of the skin can trigger the release of endorphins, that act as natural painkillers. Moreover, the rhythmic application of water can have a meditative effect, helping to calm the mind and reduce stress.

1.Full Body Affusion: water is poured over the entire body. It’s like a full-body reset button promoting overall relaxation and well-being.

2.Localized Affusion: Whether it is a stiff neck, sore back, or tired feet, targeted water application can help soothe and heal.

3. Contrast Affusion: This technique alternates between hot and cold water applications. It is like giving to the circulatory system a workout, promoting better blood flow and reducing inflammation.

4. Herbal and Mineral-Infused Affusions: Infusing the water with herbs or minerals can enhance the therapeutic effects. Lavender for relaxation, eucalyptus for respiratory health, or mineral salts for detoxification.

Health Benefits:

1. Stress Reduction and Relaxation: The combination of water temperature, pressure, and rhythmic application can calm the nervous system, reduce stress and promote deep relaxation. It is like a powerful antidote taking the body and mind for a mini-vacation.

2. Pain Management and Muscle Recovery: The targeted application of water can reduce inflammation, ease muscle tension, and promote faster recovery.

3. Immune System Support: regular affusion therapy sessions may give to the immune system a boost. The alternating hot and cold applications can stimulate circulation and lymphatic flow, helping the body flush out toxins and fight off infections more effectively.

4. Skin Health and Detoxification: The skin is the body’s largest organ. The water application can cleanse the skin, open pores, and promote detoxification.

Eventhough affusion therapy is powerful on its own, combining with other wellness practices, can create a symphony of healing. Some exciting ways to amplify the benefits of the affusion therapy sessions:

Aromatherapy and Essential Oils: The soothing cascade of water infused with the calming scent of lavender or the invigorating aroma of peppermint. Adding essential oils to the affusion therapy can engage multiple senses, enhancing the overall therapeutic effect.

Massage and Bodywork: Combining affusion therapy with massage is a match made in wellness. The water application can prepare the muscles for deeper work, while the massage can help distribute the benefits of the affusion throughout the body. It is like a one-two punch of relaxation and healing.

Nutritional Support: To maximize the detoxifying and healing effects of affusion therapy, supporting the body with proper nutrition, hydrating foods, antioxidant-rich fruits and vegetables, and adequate water intake can help the body flush out toxins more effectively and recover more quickly from treatments.

One particularly exciting area of development is the combination of affusion therapy with hydroschock therapy, which uses high-pressure water jets to target specific areas of the body for pain relief and improved mobility or virtual reality experiences with precision-controlled affusion systems that can deliver personalized treatments based on real-time biofeedback such as transporting to a tranquil waterfall during the affusion therapy.

Pool therapy exercises, known as aquatic therapy or hydrotherapy, involve performing specific movements and exercises in a pool or other body of water. The water’s unique properties, including buoyancy, hydrostatic pressure, and resistance, create an ideal environment for rehabilitation and fitness training. These exercises can benefit a wide range of individuals, from athletes recovering from injuries to older adults looking to improve their mobility and strength.

The primary advantage of exercising in water is the reduced impact on joints and muscles. The buoyancy of water supports your body weight, allowing for greater freedom of movement and reducing the risk of injury. This makes pool therapy exercises particularly beneficial for those with arthritis, fibromyalgia, or other conditions that cause joint pain and stiffness. Additionally, the hydrostatic pressure of water improves the circulation and reduces swelling, further enhancing the therapeutic benefits of aquatic workouts.

Lower body exercises improve strength, flexibility, and balance of different lower muscle groups. One of the most fundamental movements is water walking forward in waist-deep water at the beginning, then walking backward or sideways to challenge and focusing on maintaining good posture and jogging.

Leg swings, one leg forward and back, then side to side alternating legs with each repetition and knee lifts raising the knee towards the chest are excellent for improving hip mobility and strengthening the muscles around the knee joint.

Body exercises in the pool can improve arm strength, shoulder mobility, and overall upper body function: Starting with arm circles and shoulder rotations to warm up the muscles, then increasing range of motion and standing in chest-deep water, making large circles with the arms, both forward and backward, then, rotating the shoulders by shrugging them up towards the ears, back, down. Chest presses and flies are excellent for strengthening the pectoral muscles and improving upper body posture. Tri*ceps* dips and biceps curls using water resistance are effective ways to target the arms.

Rowing motions are fantastic for building back strength and improving posture: Standing with the feet shoulder-width apart, leaning forward slightly, and pulling the arms back as if rowing a boat on squeezing the shoulder blades together at the end of each “stroke.”

Pool therapy exercises have an adaptability to various health conditions and rehabilitation needs. For those with arthritis and joint pain, gentle range-of-motion exercises in warm water can provide significant relief. Slow, controlled movements like arm and leg circles, paired with the water’s buoyancy, can improve joint mobility without putting excessive stress on.

Post-surgery rehabilitation movements in the pool can accelerate recovery and improve outcomes. After knee surgery, exercises like shallow water walking, leg lifts, and gentle knee bends can restore strength and range of motion while minimizing the risk of re-injury. The beauty of pool therapy is its adaptability – the depth of the water, the speed of movements, or the level of resistance to suit the current abilities and goals of the participant can be adjusted and the sensation of weightlessness, the gentle resistance of the water, and the joy of movement could be enhanced.

Pool therapy exercises offer a gentle yet powerful approach to rehabilitation, fitness, and overall well-being and provide a safe and effective way to improve strength, flexibility, and cardiovascular health while minimizing stress on joints and muscles. Whether recovering from an injury, managing a chronic condition, or simply looking for a low-impact workout, pool therapy exercises can be tailored to meet the individual needs and goals. Pool therapy exercises not only improve the physical health but also provide a sense of relaxation and joy that comes from moving freely in the water , embracing the healing power of aquatic therapy, and letting the gentle waves to guide towards improved health and vitality.

Balance and coordination exercises are crucial for individuals with neurological conditions such as multiple sclerosis or Parkinson’s disease. The water’s supportive environment allows for safe practice of movements that might be challenging on land. For those focused on weight management, low-impact cardiovascular workouts in the pool can be a game-changer. Water jogging, swimming laps, or participating in aqua aerobics classes can provide an effective calorie burn without the joint stress associated with land-based exercises. The resistance of the water also helps to tone muscles throughout the body, contributing to overall fitness and weight loss goals(155-161)

**Floatation therapy (FT)**

Floatation therapy, known as floatation-restricted environmental stimulation therapy (REST) is a therapy intended for a therapeutic and sensory deprivation experience, in which a person lies horizontally in a float pod (a quiet, dark, isolation tank) filled with body skin temperature (approximately 35 °C) salt water saturated with high concentration magnesium sulphate (Epsom salt) that results in natural buoyancy, allowing to float effortlessly on their back, designed to limit sensory input by creating an environment free from sounds, sight and gravity’s pressure. During a floatation therapy session, patients float on their back inside the tank for approximately 1 hour.

From the perspective of detoxification, high concentration of Epsom salt in the float pod, aids in eliminating harmful substances and toxins from the body by being absorbed through the skin and taking a role in the enzymatic function leaving a sense of revitalizetion and purity. The magnesium element also helps with muscle relaxation in the prevention of cardiovascular diseases by regulating blood pressure.

 It has been suggested that floatation therapy achieves beneficial effects through deep relaxation that is induced by sensory isolation. The pod’s environment, devoid of external stimuli , allows the mind to drift into a state of deep relaxation and mental clarity reducing stress and alleviating pain. The brain naturally drops into the theta state during floating , a deep relaxation state experienced right before sleep.. This state is associated with creativity, visualization, learning and introspection. Lowering cortisol levels induces peace and tranquility. reduce stress, alleviate pain, and promote deep relaxation. Floatation therapy has been used as a treatment for a variety of psychological and physical conditions, such as chronic pain, fibromyalgia, and multiple sclerosis.<https://www.ncbi.nlm.nih.gov/books/NBK595362/>  Floatation therapy may not be appropriate for patients with conditions including epilepsy, kidney disease, low blood pressure, any contagious disease, open wounds, or claustrophobia.<https://www.ncbi.nlm.nih.gov/books/NBK595362/>

Float Pod therapy enhances emotional well-being and mood by reducing anxiety. The sensory deprivation allows the mind to enter a deeply restful state associated with increased creativity and problem solving abilities. It offers a holistic approach to mental health to reset and recharge itself. It also relieves tension in the muscles and joints, mitigates chronic pain and improves sleep quality. By counteracting gravity’ effects, the spine and musculoskeletal structure experience relief promoting optimal body function. This is unique therapy, that also allows partners to float together in a specially designed tank, promoting relaxation, bonding, and potentially enhancing relationship dynamics. (162)

**Scuba diving therapy (SDT)**

The aquatic environment enables the relaxation of muscles, as a positive effect on spasticity and increases the joint range of motion significantly limited in the natural environment and improves movement and coordination in a much easier way than in a terrestrial environment. Such exercises have a positive effect on the respiratory system and blood circulation.

Diving encourages to spend time with other people and, gives an opportunity to be in a group whose members are people without disabilities, as well as people with locomotor system dysfunctions, giving the sense of affiliation with a group and responsibility for its members. Diving may eliminate the limitations resulting from disabilities and enables people with disabilities to exceed the possibilities of their able-bodied peers who report average levels of physical activity. The awareness of being a disabled person doing something unusual helps the disabled feel exceptional, which facilitates the process of accepting one’s own status.

Apart from the initial health condition, the factors having influence on human body include pressure under water, breathing gas, temperature, type of diving environment, mental barriers and possible problems with the equipment. The studies showed that diving may improve the self-assessment of a disabled person.

Classes in the aquatic environment, such as swimming and diving, engage the respiratory system more intensely. Training in breathing under water increased the peak and endurance exercise capacities in people with chronic obstructive pulmonary disease. Exercises in the water improve, at a statistically significant level, the flexibility, strength and aerobic efficiency of the knees and hips in adults with a degenerative disease of the joints. The aquatic environment is optimal for many rehabilitation exercises, as the loss of body weight after immersing into water enables one to make movements that are impossible or very difficult on land. Scuba diving for the disabled may be an alternative as an efficient form of rehabilitation, both in the physical and mental aspects.

Diving is an important example of how to overcome barriers and accomplish a goal unattainable to people without disabilities from a lack of awareness, imagination and determination. Diving gives people with disabilities a sense of belonging to the elite, doing something unusual, overcoming many obstacles and successfully working to improve their health status and proving that anything is possible to exceed limits, and it is worth doing to accept one’s fate. Diving may become one of the well-accepted and successful forms of rehabilitation for individuals with disabilities to help them to improve their mental and physical conditions, which will translate into the improvement of their overall functions. This innovative approach combines the therapeutic benefits of being in water with the psychological boost of exploring underwater environments, offering potential benefits for both physical and mental health. (163)

**Riding the wave**

The art of “riding the wave” involves controlling what can be done within a situation, and leaning into what cannot be controlled.. Learning the difference can take a lot of practice but is a very important part of the process. All human beings want to feel like they have some control and influence over situations in their lives., but they can control certain factors that contribute to situations happening (or not), as well as how and when those situations happen. . Yet, there are many things that they cannot control, but make peace with the idea even if they really don’t like it!

Whatever factors can be controlled one side, “riding the wave,” is the other side, the ‘surrender’ part. ‘surrender,’ does not mean a defeat, but an active choice to make peace with what is happening, rather than feeling like giving up being forced to. Surrender involves the acceptance of the uncomfortable feelings that come with some situations instead of trying to avoid or eliminate them. Riding the wave doesn’t mean to learn to like every situation, which would be wildly unrealistic. Rather, it means that there are hard and undesirable factors that are consciously choosen to surrender to, knowing that how one handles these factors determines the outcome. Intentional surrender is an act of control in-and-of-itself!

Instead of using energy to try to change things that cannot be changed, shift the energy to ride the wave and having confidence to *handle whatever life hands.* This can prevent unproductive exhaustion and would save energy to put towards things that  *can* be changed. The story we tell ourselves (ie our perspective), the healing we do, the skills we learn, and how we decide to proceed are all important uses of our energy that are within our control. All these things affect outcomes when they come up in the life as waves and where the sense of intention and power are manifested.. Focusing on these things is the productive and empowering work that is within control. The power does not lie in trying to stop or fight the waves; rather comes from how to navigate situations and make sense of those outcomes. Where and to what decision to surrender to is within control and make ALL the difference! So, next time treading water or being caught up in one of life’s riptides, slow down and consider what is and what is not within control, then decide to ride the wave on the things that are not.

Notice your breath’s natural rhythm

Take a deep breath and Relax

 Scan the body and notice the places in the body under tension to soften

 Resist the impulse to control and move actively the awareness toward this sensation in the body.

 Stay with the feeling, how does it feel now

 Instead of resisting the impulse to name or label the feeling, simply feel and watch

 Witness your experience without judgment

 Let go any evaluating, judging, or comparing feeling about this experience

 Watch your experience even as it may intensify and change, stay with it

 Allow your experience to unfold just as it is

 Surrender to your experience and let it happen

Suppression (or denying a feeling is present) has been shown to increase sympathetic activity, decrease a sense of connection, and negatively impact memory. Distraction (or paying attention to something other than the feeling) reduces the immediate intensity of a feeling, but impedes one’s ability to learn from experience.

Urge surfing is a technique for managing one’s own unwanted behaviors. Rather than giving in to an urge, a person learns to ride it out, like a surfer riding a wave. After a short time, the urge will pass on its own. This technique can be used to stop or reduce drug and alcohol use, emotional reactions such as “blowing up” when angry, gambling, and other unwanted behaviors. Urge surfing handout describes how to “surf” urges effectively. Like an ocean wave, urges gradually build intensity, they peak, and then they fade away. While riding out an urge, it can help to practice basic relapse prevention skills. This handout offers education on managing triggers and using delay and distraction. It is normal to experience emotional discomfort while riding out an urge. Urge surfing is very popular in the treatment of addictions, as a distress tolerance skill in dialectical behavior therapy (DBT).

Notice the feeling

Step back

Get unstuck

Experience the Feeling As a wave coming and going

Try not to block the feeling

Don’t try to get rid of it

Don’t try to push it away or hold on to it or make the feeling bigger

Remember, you are not the feeling

You don’t need to act on it

Remember times when you have felt differently

Become more comfortable with your feeling

Observe

Don’t judge it

Accept it as part of you

Name your feeling

Invite it home for dinner and sit with it. (164-168)

**The Kneipp therapy**

The Kneipp therapy ( known as “Kneipping”) is a traditional curative method that promotes the prevention of illness and the preservation of health. It is aimed at stimulating circulation, strengthening the immune system, and improving the vegetative nervous system. Kneipp therapy is a holistic method and encompasses five foundational pillars: Exercise, Nutrition, Water, Plants, and Balance. Classic Kneipping consists of multiple affusions of water as well as additional therapies including barefoot walking, walking on pebbles, baths, rinses, and wraps. After healing himself of tuberculosis through immersion baths in the Danube, Sebastian Kneipp (1821-1897) recognised the positive effects on the immune system of repeated temperature stimulus through external water applications. Water as a temperature stimulus not only mobilises the body’s own powers but also stimulates the vegetative nervous system and the hormonal system. The five-pronged concept devised by Kneipp for his therapy combines insights from hydrotherapy (affusions, baths, rinses, wraps, and packs) with the knowledge of herbs, healthy nutrition, exercise, and the importance of emotional well-being. This carefully-considered health concept has been practised, disseminated, and refined for over a century. Many effects brought about by Kneipp treatments, such as calf wraps to treat a high fever, water treading to strengthen the immune system, or a soothing hay pack to remedy painful joints have been scientifically confirmed.

As Kneipping promotes the self-empowerment of the user in his or her approach to a holistic concept of health and the use of available resources of nature, such as water and herbs, this also has a positive effect on long-term development. Kneipping can be learned and practised without a great deal of time or expense. Kneipp’s teachings continue to be utilised and passed on in sanatoriums and health spas, in the area of medicine, and particularly in Kneipp-related clubs and associations. Active Kneipp practitioners in Austria are involved in some 200 “Kneipp Aktiv Clubs”, provincial organisations, and the Österreichischer Kneippbund (Austrian Kneipp Federation). Through a number of measures initiated by the Kneippbund in the areas of medicine, child-raising, tourism, and education—for example “Kneipp in Kindergarten”—as well as extensive publication activities and public-relations work, “Kneippen” is being made accessible to young people as well. The Kneippbund places particular importance on quality assurance, guaranteeing that the health-promoting benefits are maintained.

Word quickly spreads among the population that the "water doctor" Sebastian Kneipp uses water for all kinds of illnesses and works wonders with his treatments. In 1886 he made his big breakthrough with the book "Meine Wasserkur" (My Water Cure), and [hydrotherapy](https://www.kneipp.com/us_en/the-kneipp-guide/bathing-guide/hydrotherapy-101/) according to Kneipp was born.

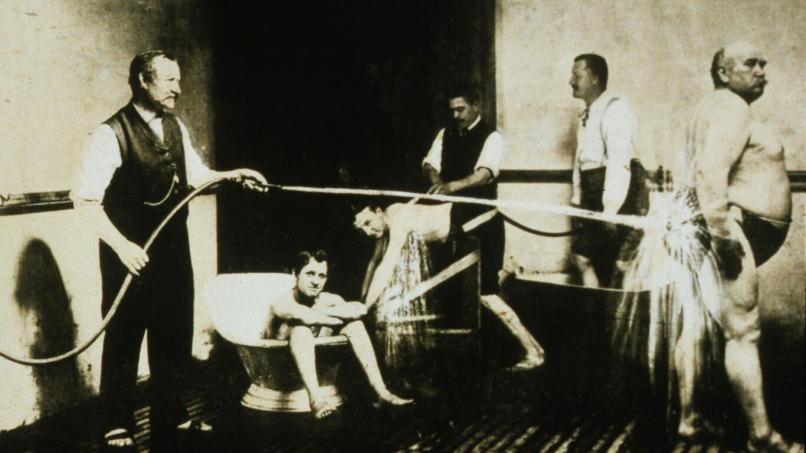
Hydrotherapy according to Sebastian Kneipp (1821-1897) is the most famous of the five interlocking individual components of the therapeutic Kneipp naturopathy concept , consisting of what would be grouped into lifestyle and mind-body interventions , healthy nutrition, exercise, phytotherapy and hydrotherapy.

Kneipp’s hydrotherapy (KH) is charcterized by the frequent us eof cold water and distinguishes between more than 120 different water applications including washing, pouring, bathing, wrapping, steaming and packing for disease prevention and therapy. For Kneipp, cold water is the main remedy of choice, while warm water is usually only used in alternation with cold water.

Scientifically shown that cold water functions as a stimulus causing a compensating and regualting reaction, on the level of the cardiovascular system and in the area of the endocrine/and immune system and psyche. Repeated stimuli lead to adapted bodily reactions that beneficially influence inflamamtion and metabolic processes. By repeating cold water applications in medical Kneipp cures over several weeks, the physiological reaction adapts to the stimuli. Additionally water, which is excelelnt solvent for bath additives and can be used therapeutically in baths due to its hydrostatic pressure. (169-170)

“If there is a cure for me, it will be water. Water, properly applied, is the most innocent remedy.

Sebastian Kneipp



**Fig.22. Kneip therapy**

**Japanese water therapy (JWT)**

Japanese water therapy involves drinking room-temperature or warm water on an empty stomach after waking to cleanse the digestive system and regulates gut health, which can heal a variety of conditions spanning from constipation and high blood pressure to type 2 diabetes and cancer. Supposedly, Japanese water therapy gets its name from being widely used in Japanese medicine and among the Japanese people. The therapy includes the following steps that should be repeated daily:

1. Drink four to five 3/4-cup (160-ml) glasses of room-temperature water on an empty stomach upon waking and before brushing your teeth, and wait another 45 minutes before eating breakfast.
2. At each meal, eat only for 15 minutes, and wait at least 2 hours before eating or drinking anything else.

According to practitioners, Japanese water therapy must be done for different periods to treat different conditions. Here are some examples:

* **Constipation:** 10 days
* **High blood pressure:**30 days
* **Type 2 diabetes:** 30 days
* **Cancer:**180 days

Following this therapy protocol may result in weight loss because it can cause you to restrict your calorie intake. Using Japanese water therapy drinking several glasses of water per day, help to stay adequately hydrated. Drinking enough water, to adequate hydration has numerous benefits including optimal brain function, sustained energy levels, and body temperature and blood pressure regulation as well as prevent headaches, constipation, and kidney stones. Most people get enough fluid by simply drinking to satisfy their thirst.

Japanese water therapy is associated with potential side effects and precautions. Water intoxication, or [overhydration](https://www.healthline.com/health/overhydration), which can occur drinking an excessive amount of water in a short period of time (about 4 cups (1 liter) of fluid per hour, is the maximum amount that a healthy person’s kidneys can handle at once), can severely lower the sodium concentration in the bloodstream and lead to a dangerous condition called [hyponatremia](https://www.healthline.com/health/hyponatremia) due to salt being diluted by excessive fluid and may cause nausea, vomiting, seizures, coma, and even death if untreated[. This serious condition that can result in death, is rare in healthy people whose kidneys are able to quickly get rid of excess fluid. People at increased risk of hyponatremia include those with kidney problems, endurance athletes, and people who abuse stimulant drugs. Another downside of Japanese water therapy is being excessively restrictive due to its guidelines on the timing of meals and eating within a 15-minute window. There is also a risk of overeating or eating too quickly within the allotted 15-minute eating windows, which can cause indigestion or lead to weight gain. It is also important to note that Japanese water therapy should not be used as a replacement for medical care.](https://www.ncbi.nlm.nih.gov/pubmed/27803013) (171-172)Formun Üstü

**Balneotherapy**

Balneotherapy is a clinically effective complementary approach in the treatment of low-grade inflammation- and stress-related pathologies. The hormetic effects of balneotherapy can be related to non-specific factors such as heat—which induces the heat shock response, and therefore the synthesis and release of heat shock proteins—and also to specific biochemical components such as hydrogen sulfide (H2S) in sulfurous water and radon in radioactive water. The beneficial effects of balneotherapy and hydrotherapy are consistent with the concept of hormesis, and thus support a role for hormesis in hydrothermal treatments.

Hormesis is a biphasic dose-response phenomenon in which exposure of a cell or organism to a low dose of a chemical agent or condition induces stimulation or adaptive beneficial effects, while higher doses cause inhibition or toxic effects . This response to low doses of stress is considered an adaptive compensatory stress process following an initial disruption in homeostasis, enhancing the ability of the organism to withstand more severe stress. A hormetin has been defined as any condition that may be potentially hormetic in physiological terms by activating or upregulating one or more cellular and molecular pathways of stress response that protect against a similar but more severe stress.

Apart from chemicals and toxins, there are several conditions and factors that can be considered hormetins: biological hormetins such as infections, hypoxia/ischemia, endogenous metabolic products, dietary caloric restriction, intermittent fasting, and micronutrients; psychological hormetins such as mental challenge and meditation; and physical hormetins such as exercise, heat, and radiation . Repeated mild heat stress-induced hormesis affects various parameters of cellular aging and other functional characteristics, such as differentiation, wound healing and angiogenesis. These hormetic effects lead to a significant biological response that results in an overall improvement of the living system . In this context, thermotherapeutic strategies such as balneotherapy and hydrotherapy can be considered potential hormetic interventions.

In Medical Hydrology and Physical Medicine, spa therapy consists of multiple techniques based on the healing effects of water, including balneotherapy and hydrotherapy. Balneotherapy is the set of methods and practices which, based on scientific evidence, use medically and legally recognized mineral-medicinal waters, muds, and natural gases from natural springs for therapeutic purposes inside the facilities of thermal spa centres. Particularly, muds (or peloids) are maturated muddy suspensions composed of a complex mixture of fine-grained materials of geologic origin, mineral water, and commonly organic compounds from biological metabolic activity. Thus, mud therapy or pelotherapy is a balneological intervention that consists of the external application of mud for therapeutic purposes.

Temperature has a central role in the effects of balneotherapy. Mineral-medicinal water and mud are generally applied hot since they are excellent vehicles for the transference of heat—being able to hold heat and release it slowly—so these treatments can be considered thermotherapeutic interventions. The peculiarity of balneotherapy is that its beneficial effects on the organism are brought about not only by the physical properties of mineral-medicinal water and mud, but also by their chemical and biological composition. Conversely, in other spa treatments such as hydrotherapy—in which plain tap water is used—only the physical properties of water (temperature, hydrostatic pressure, hydrodynamics, buoyancy, viscosity, electric conductivity, etc.) take part in the beneficial effects of the intervention.

Balneotherapy and mud therapy have been used empirically since time immemorial to treat a wide range of conditions. Thermal baths are considered an integral part of traditional medicine in many cultures and countries (France, Italy, Spain, Portugal, Germany, Austria, Switzerland, Turkey, Poland, Czech Republic, Hungary, Romania, Russia, Israel, Japan and others), and they are a relevant part of the public health systems of many countries within and outside Europe. Balneotherapy is an effective, well tolerated, complementary approach in the treatment of several pathologies—mainly those related to chronic inflammation—such as cardiovascular, respiratory, gastrointestinal, endocrine, and neurological conditions, and more importantly in skin and rheumatic disorders.

Studies including high-quality meta-analysis and systematic reviews have reported the beneficial effects of balneotherapy, including mud therapy, on different clinical outcomes in patients with osteoarthritis (OA) , rheumatoid arthritis (RA), fibromyalgia (FM) , and other rheumatic conditions. Of all these pathologies, OA is the most commonly treated with balneological interventions. The main clinical parameters improved by balneotherapy and mud therapy in OA are analgesic drug consumption, function, stiffness, pain, and quality of life . Since these therapies have little to no adverse effects, they are especially important for OA patients, who usually are elderly patients with multimorbidity- and polypharmacy-related risk of adverse events. The Osteoartritis Research Society International (OARSI) has stated in its guidelines that balneotherapy is appropriate in OA patients with comorbidities, for whom treatment options are limited.

Balneotherapy causes local and generalized physiological effects in the organism, which are exerted through both physical mechanisms—mainly linked to heat therapeutic effects—and chemical and biological properties of the agents. As a result of the elevated application temperature—generally ranging from 38 to 42 °C—thermotherapeutic effects are the basis of these treatments. Absorption of biologically active inorganic and organic substances through the skin also play a role in the effectiveness of balneotherapy. In vitro and in vivo studies have established that some water-soluble minerals are able to permeate human skin and seem to be the key mechanism responsible for the improvement in some clinical outcomes, in both balneotherapy and mud therapy, thus implying that those beneficial effects are not exclusively linked to the action of heat.

Each mineral-medicinal water and mud around the world has different distinctive physical properties and chemical composition. According to their predominant ions and gases, mineral-medicinal waters may be classified as chlorated, sulfated, bicarbonated, ferruginous, carbogaseous, sulfurous and radioactive. It is known that, different diseases require agents with different chemical compositions in order to attain therapeutic results. Whichever of these mechanisms are implicated to a lesser or larger extent, the physiological responses arising from balneotherapy consist mainly of neuroendocrine and immunological effects that have been most widely studied in rheumatic pathologies.

In several low-grade inflammation-related pathologies—especially in rheumatic diseases—balneotherapy and mud therapy have been reported to cause a reduction in serum concentrations of pro-inflammatory cytokines TNF-α and IL-1β , and regulatory cytokine IL-6 , as well as an increase in anti-inflammatory growth factor IGF-1 . Mud therapy can also decrease circulating levels of the adipokines adiponectin and resistin in OA. All these cytokines and adipokines are important mediators of inflammation and cartilage metabolism, and thus their modulation after balneotherapy leads to anti-inflammatory-mediated chondroprotective effects that may play a beneficial role in rheumatic conditions such as OA.

Matrix metalloproteinases (MMP) are involved in cartilage degradation . MMP-3 serum levels decrease after mud therapy in OA patients —either as a direct effect of the intervention or as a consequence of the reduction in pro-inflammatory mediators such as cytokines that promote MMP secretion—suggesting that mud therapy contributes to extracellular matrix integrity. In fact, serum cartilage oligomeric matrix protein (COMP) concentration—an indicator of cartilage turnover—decreases after balneotherapy.Moreover, C-reactive protein (CRP) levels—which rise in response to inflammation—decrease after balneotherapy in patients with rheumatic and cardiovascular pathologies . Prostaglandin E2 (PGE2) and leukotriene B4 (LTB4) are other important inflammatory mediators. There is evidence that balneotherapy and mud therapy reduce circulating levels of these biomarkers in patients with rheumatic pathologies.

It is well known that the inflammatory response plays a key role in the development and persistence of many pathological pain states. Since they are part of the inflammatory response, certain pro-inflammatory cytokines such as IL-1β, IL-6, and TNF-α are strongly involved in the process of inflammatory and neuropathic pain. They can directly modulate neuronal activity in the peripheral and central nervous system and promote the production of other mediators related to inflammation and pain—such as substance P and PGE2—contributing to hyperalgesia and allodyinia . In this way, reduction in these mediators’ levels after balneotherapy can also be associated with the analgesic effects of the treatment, as demonstrated by concomitant declines in perceived pain.

OA patients presented a reduction in the circulating neutrophils’ functional capacity—i.e., phagocytic and microbicidal activities —that improved significantly after mud therapy. Circulating monocytes’ phenotype and functional capacity seem to be also involved in the innate/inflammatory response induced by this treatment. In addition, changes in the percentage of circulating regulatory T cells are also implicated in the cytokine-mediated anti-inflammatory effect of balneotherapy.

It is known that the hypothalamic-pituitary-adrenal (HPA) axis is activated in response to various stress factors—including hyperthermia—leading to β-endorphin (a peptide with morphine-like analgesic effects ), adrenocorticotropic hormone (ACTH), and cortisol release, the latter being especially important because of its anti-inflammatory effects and ability to inhibit the production of most cytokines. At the same time, activation of the sympathetic nervous system (SNS) by stressors stimulates the release of catecholamines.

Hyperthermia-induced activation of the HPA axis and SNS has been reported mostly in healthy subjects undergoing plain hydrotherapy or sauna baths. This activation was manifested by increased circulating concentrations of ACTH cortisol, growth hormone (GH), prolactin, β-endorphins , and noradrenaline (NA). In addition, heat stress induces a cellular response, the heat shock (HS) response, in which heat shock proteins (Hsp) are synthesized and released. Maintenance of the HS response by repeated mild heat stress causes hormetic effects in the organism. In this way, HS response and Hsp could play a role in the beneficial effects of balneotherapy.The hormetic effects of balneotherapy are related to different factors. The main factor that is common to all types of mineral-medicinal waters and muds is heat. Other factors are specific biochemical components of water such as hydrogen sulfide (H2S) and radon.

The therapeutic capacity of heat consists of changes in body tissue temperature for a certain time with the aim of producing physiological responses that contribute to support healing processes or alleviate pain and other symptoms , and it is linked to the ability of organisms to respond to stress and produce cellular responses of adaptation . Whereas severe heat stress leads to cellular damage and cell death, mild heat stress induces the HS response, which protects cells and organisms from severe damage, allows resumption of normal cellular and physiological activities, and leads to a higher level of thermotolerance.

The stress responses have the potential to induce higher levels of stress tolerance and greater resistance to subsequent stress damage from more than one type of stress. In this way, mild heat stress can protect from oxidative stress or toxin damage. In the HS response, cells activate a signaling pathway leading to the expression of Hsp. The Hsp70 (70 kDa heat shock protein) family consists of a class of Hsp that includes the stress-inducible Hsp70 (Hsp72, 72 kDa). Under normal physiological conditions, Hsp72 is expressed at low levels.

Following stress stimuli such as heat and inflammation, synthesis of intracellular Hsp72 (iHsp72) and release of extracellular Hsp72 (eHsp72) are increased markedly. iHsp72 plays a crucial role in cytoprotection and cytotoxicity tolerance as an intracellular molecular chaperone involved in cell aging, survival, and protection against potentially harmful stress stimuli. The role for Hsp in the thermotherapeutic benefits induced by balneotherapy, supports the relationship between hormetic pathways and hydrothermal treatments. Nevertheless, it is still necessary to determine the optimal intensity, duration, and interval of heat stimulation for clinical application, particularly in inflammation- and stress-related illnesses.

The active molecule in sulfurous and sulfated mineral-medicinal waters is H2S, a hormetin that can actively penetrate the skin. While high levels of H2S are extremely toxic, low levels are tolerated and have potential cytoprotective effects, with anti-inflammatory and antioxidant applications. H2S has important physiological functions as an endogenous cell signaling molecule on the regulation of inflammation (through NF-κβ) and oxidative stress—acting as a reactive oxygen species (ROS) scavenger and increasing levels of superoxide dismutase (SOD) and glutathione (GSH)—among many other functions.In vitro, several studies have demonstrated antioxidant and anti-inflammatory effects of this type of waters and have confirmed that sulfurous waters have direct free radical-scavenging activity, reduce ROS and reactive nitrogen species (RNS) released by human neutrophils during respiratory bursts, and protect against oxidative DNA damage, thus contributing to the therapeutic effect of these waters in inflammatory respiratory diseases.

There is evidence that H2S treatment reduces both spontaneous and IL-1β-induced secretion of IL-6, IL-8 and RANTES, as well as the expression of MMP-2 and MMP-14 in cultured fibroblast-like synoviocytes from OA patients and blocks the production of inflammatory cytokines (IL-8, IL-1β, TNF-α, IL-6 and IL-10) and counterbalances the formation of ROS and RNS by human monocytes, and reduces NO, PGE2, IL-6 and MMP13 released by OA chondrocytes by downregulating genes involved in the synthesis routes of these molecules as well as NF-κβ nuclear translocation.In vivo, reductions in serum levels of malondialdehyde (MDA) and carbonyls, and in SOD and catalase activity have been found after balneotherapy with sulfurous water in rheumatic diseases, thus reflecting a reduction in oxidative stress that may contribute to reduce the inflammatory and catabolic status. Indeed, sulfurous waters are clinically effective in the treatment of OA and RA patients .

Apart from bathing, another lesser-known modality of balneotherapy involves drinking mineral-medicinal water, namely bicarbonated, carbogaseous, and sulfurous waters. In healthy individuals, drinking sulfurous water for two weeks caused a decrease in their circulating levels of lipid and protein oxidation products (MDA, carbonyls and advanced oxidation protein products) and an increase in their antioxidant capacity and thiol levels. The combination of bathing in and drinking sulfurous water is a common practice, and can increase plasma thiol levels and decrease circulating levels of MDA, carbonlys, MMP-2, COMP and TNF-α in OA patients. These improvements in the redox status could potentially confer protection against age- and disease-related oxidative damage.

In a series of very interesting studies, beneficial effects of drinking sulfurous water on diabetes and long term diabetes-associated complications have been reported. Diabetic rats drank sulfurous mineral-medicinal water for 6–7 weeks. Anti-diabetic effects of sulfurous water were evidenced by increased serum concentrations of insulin, C-peptide and IGF-1, and by a reduction in glucose and glycated hemoglobin levels, indicating a return towards normal conditions .

Cardiac GSH and protein thiols increased while glutathione disulfide levels decreased, thus boosting the antioxidant status. This improvement in cardiac GSH levels caused a reduction in NF-κβ as well as MMP-2, procollagen-1 and Fas-L gene expression in the left ventricle. By counteracting these pro-apoptotic and pro-fibrogenic factors, sulfurous mineral water prevented the development of fibrosis in the heart.

Regarding diabetic nephropathy, sulfurous water counteracted the elevation of renal thiobarbituric acid reactive substances and replenished GSH levels in diabetic rats with impaired kidney function. Improvements in renal redox balance were reflected on improved kidney function. Diabetes impairs testicular function, and drinking sulfurous water improved the seminiferous tubule structure as well as the number of spermatogenic cells and testosterone levels in diabetic rats, probably due to an increase in testicular GSH by blocking the overexpression of apoptosis-related regulatory proteins such as Bax/Bcl-2, cytochrome *c*, caspase-9 and -3, and p53. Balneotherapy using waters rich in H2S (at low concentrations as found in natural springs) is able to exert hormetic therapeutic effects in different pathological conditions related to inflammation. Hormetic effects of thermal waters rich in sulfur could be a result of the synergistic effect of two different hormetins: H2S and heat.

Mineral-medicinal radioactive waters rich in radon are also considered a therapeutic hormetic strategy. Radon spa therapy consists of the intake of radon either by inhalation or by transcutaneous absorption of radon dissolved in water, and it is applied in several inflammatory diseases such as asthma, bronchitis, psoriasis and arthritis. Although ionizing radiation has been shown to be carcinogenic at high doses, at low doses it produces biologically beneficial effects by initially causing low-level molecular damage, which then leads to the activation of one or more stress response pathways and therefore induces adaptive mechanisms that may prevent cancer as well as other adverse health effects. Mechanisms of radiation-induced hormetic response include activation of DNA repair, scavenging of free radicals, elimination of damaged cells by apoptosis, synthesis of stress proteins such as Hsp, and stimulation of the immune response.

Radon spa therapy was found more effective than thermotherapy alone in enhancing antioxidant functions (SOD and catalase activities) and in increasing ACTH, β-endorphin, and insulin levels, among other biomarkers. This result indicates that radon in spa therapy adds further beneficial hormetic outcomes to those of thermal interventions alone, suggesting a synergistic effect of heat and radon. Therefore, radon spa therapy at optimal radon concentrations could be a useful complementary therapy in metabolic syndrome and rheumatic diseases such as OA.

In the context of rheumatic diseases, the anti-inflammatory mechanisms of this strategy are a decrease in NO and ROS levels, increase in heme-oxygenase 1 and TGF-β levels, TNF-α suppression, activation of transcription factors, and enhancement of regulatory T cells. Thus, low-dose ionizing radiation exposure is able to diminish pivotal inflammatory processes associated with arthritis, by inducing a switch from a pro-inflammatory to an anti-inflammatory phenotype following the hormetic response. Cinical trials have reported significant long-term beneficial symptom-related effects of radon balneotherapy in rheumatic diseases, lasting up to nine months post-intervention. Compared to radon-free treatments, radon balneotherapy was superior in terms of pain relief, function improvement, reduction in anti-inflammatory and analgesic drug consumption, and persistence of these benefits over a longer term. Overall, the results suggest beneficial long-term clinical effects of radon spa therapy—consistent with the concept of hormesis—as a complementary strategy in the treatment of rheumatic conditions, especially RA and OA.

Balneotherapy (from Latin: balneum, "bath") is the treatment of disease by bathing, usually practiced in spas. Balneotherapy may involve hot or cold water, massage through moving water, relaxation or stimulation. Mineral waters at spas are rich in particular minerals (sulfur, selenium, radium) which can be absorbed through the skin. Balneotherapy may be recommended for a wide range of illnesses, including arthritis, skin conditions and fibromyalgia.

Seven ways by which balneotherapy heals:

1. Bathing in hot springs gradually increases the temperature of the body, thus killing harmful germs and viruses.

2. It increases hydrostatic pressure o the body, thus increasing blood circulation and cell oxygenation. The increase in blood flow dissolves and eliminates toxins from the body.

3. Hot springs bathing increases the flow of oxygen-rich blood throughout the body, bringing improved nourishment to vital organs and tissues.

4. Bathing in thermal water increases body metabolism, including stimulating the secretions of the intestinal tract and the liver, aiding digestion.

5. Repeated hot springs bathing (especially over 3- to 4- week period) can help normalize the functions of the endocrine glands as well as the functioning of the body's autonomic nervous system.

6. Trace amounts of minerals such as carbon dioxide, sulfur, calcium, magnesium, and lithium are absorbed by the body and provide healing effects to various body organs and system. These healing effects can include stimulation of the immune system, leading to enhanced immunity; physical and mental relaxation; the production of endorphins; and normalized gland function.

7. Mineral springs contain high amounts of negative ions, which can promote feelings of physical and psychological well-being.

**Mechanisms of action of balneotherapy**

Mechanical Effects

Increased buoyancy and hydrostatic pressure during immersion in thermal mineral water cause many physiologic changes. Immersion to the suprasternal notch in mineral water (35°C) results in a cascade of reactions including increased diuresis, natriuresis, and cardiac output. The basis of these physiological effects is considered to be the hydrostatic pressure, which forces approximately 700 ml from the lower extremities to the central compartment.

Thermal Effects

Hot stimuli influence muscle tone and pain intensity, and reduce muscle spasm. Thermal stress provokes a series of neuroendocrine reactions. In particular, the heat stimulates the release of adrenocorticotropic hormone (ACTH), cortisol, prolactin and growth hormone (GH), without altering their circadian rhythm. The effect of thermal stress on the hypothalamus-pituitaryadrenal axis seems to be particularly important for the antiedemigenous and anti-inflammatory actions of corticosteroids, as well as for the frequent alteration of the axis during some rheumatic disease. The increase in betaendorphin demonstrated to occur with various spa therapy techniques has an analgesic and anti-spasticeffect that is particularly important in patients for whom pain is the prevalent symptom.

Chemical Effects

A significant increase in serum concentrations of bromine, rubidium, calcium and zinc, was documented in patients with psoriatic arthritis who bathed in the Dead Sea. The penetration of the solutes is presumably influenced by the length of bathing time, the temperature of the thermal water, its composition and other factors Furthermore, it has been reported that the direct application of mud-pack has greater clinical effects than the application of nylon covered mud pack in patients with knee OA.

Immunological Effects

Since sulphur baths have been successfully used in various skin immunomediated afflictions, it has been suggested that absorption through the skin of trace elements present in mineral water and mud packs may affect the immune system. Thermal stress has an immunosuppressive effect. A stimulatory effect of the immune response appear to prevail at a moderate increase of local skin temperature, with increase of pro-inflammatory cytokines interleukin (IL)-6 and IL-1β, whereas higher temperatures (40 - 41°C) suppress immune functions. Significant reduction in circulating levels of T lymphocytes has been demonstrated in healthy volunteers treated with hyperthermal baths and in patients with respiratory and cutaneous atopy. Hyperthermia-induced T-lymphocytopenia and eosinopenia may be due to a redistribution of the cells, probably due to the increase of ACTH and cortisol provoked by thermal stress.

Anti-inflamatory Effects

Circulating levels of Prostaglandin E2 (PGE2) and Leukotriene B4 (LTB4), which are important mediators of inflammation and pain, were reduced in patients suffering from fibromyalgia who undergo mud-packs or balneotherapy. A reduction in the cytokines IL-1β and TNF-α has been demonstrated following a cycle of mud-baths therapy (temperature > 41C°)in patients with Osteoarthritis.

Crenotherapy, a branch of balneotherapy, is a method in which mineral waters are used as a therapeutic internal cure by ingestion. There are documents attesting that 2500 years ago, Herodotus recommended the 21-day cure of mineral water, Mineral waters, based on biological activity, can be classified as: cathartic waters, diuretic waters and waters with antiphlogistic properties. Depending on their composition, there are indications of therapeutic cures in which simple alkaline or bicarbonate waters that contain at least 1 g of salts/liter, with the predominance of bicarbonate ion bound to Na and K cations are used. The effects of these waters on the digestive tract reside in the action of Na/K bicarbonate, an alkaline substance and their ingestion reduces the chlorhidropeptic secretion (when ingested an hour and a half before a meal) or stimulates it (administered during a meal), also affecting gastric motility and bile ducts, such as fluidization of the bile, depending on the method of administration.

Chlorosodium waters used as internal treatment are hypotonic or isotonic waters, with concentrations below 10 g Na Cl/liter. They stimulate gastric and intestinal secretion, activating digestive enzymes (pancreatic-intestinal amylase), increasing gastrointestinal peristalsis reflexively, the elements stimulate the vagus nerve.Alkaline water also results in a decrease in cardio-vascular risks, reducing morbidity and mortality in the elderly population presenting comorbidities. Alkaline water having a minimum of 1 g of salts/liter with a preponderance of the bicarbonate ion and a pH above 7.0, has proven health-promoting benefits, leading to an equalization of the pH of the entirebody.Alkaline-earth sodium bicarbonate, high-calcium, and high-magnesium waters have an excitation effect on gastric secretion through the predominance of CO2, NaCl, H2S, or sulfates.

Sulfurous waters stimulate gastric secretion, are choleretic, cholecystokinetic, gastric, and intestinal motor stimuli. Hydrogen sulfide, which is responsible for the stimulating effect on the enzymatic and metabolic processes in the gastrointestinal mucosa, regulates the function of biological systems and plays a vital role in various systems and diseases. Hydrogen sulphide, in optimal concentrations, protects the gut flora from the lesions caused by infections, medicine/food supplements and preservatives, stimulate the resorption of the inflammation and cure local wounds. The lipid normalizing effects such as reductions in total cholesterol, triglycerides and non-esterified cholesterol and a significant increase in HDL- cholesterol, of balneotherapy, especially with sulphurous waters, have been reported for decades. The H2S concentration in healthy adults varies between 0.3-3.4 mmol/l, the higher concentrations being able to cause injury to the intestinal microbiome, disturbing the processes in which it is involved.

The sulphurous mineral waters above the concentration of 20 mg/l are only used as external cures. In addition, the quantity of water used in sulphurous water crenotherapy is small, 50-100 ml/day up to a maximum of 400 ml/day.Depending on the chemical composition of different sulfur waters, their effect on the digestive tract is different. The potential harmful effects of sulfate waters may lead to increased transaminases in vulnerable subjects, thus is contraindicated in patients with hepatitis. The comprehensive medical history and the complete clinical evaluation of the patient before crenotherapy indication are imperative. The benefits, the potential side effects, and therapeutic alternatives should be considered before its initiation. In current practice, sulphurous waters with concentration below 20 mg/l are used as an internal cure, because H2S has anti-diabetic effects, anti-oxidant properties and antiaging effects, as it inhibits the DNA alteration.

Oligoelements play essential roles in the metabolism and function of the gastrointestinal and renal tract. In sodium, magnesium, and calcium sulfate waters, the effects are choleretic, cholecystokinetic and laxative. Mineral calcium and magnesium sulfate waters are confirmed to have ahypoglycemic and lipid-lowering action. They are used as alternative therapeutic approaches of metabolic syndrome and mild forms of diabetes mellitus, preventing progression to disabling complications, such as diabetic retinopathy of diabetic foot. The effects on the secretion of the stomach are different, depending on the complexity of the chemical composition.

The indications regarding the dosage and the administration method are individualized and depend on the patient's condition and the experience of the physician. The choleretic effect is helpful in biliary dyskinesia but must be used with caution in patients with biliary microlithiasis, being a possible trigger for calculous migration and cistic or common bile duct (CBD) obstruction, responsible for acute cholecystitis and angiocholitis, which requires rapid surgical treatment. The main diseases of the digestive tract treated by crenotherapy are gastro-duodenal dyspepsia, chronic gastritis, duodenitis, gastric or duodenal ulcer, sequelae after surgery, idiopathic gastric dyspepsia, chronic, nonspecific enterocolopathy, chronic constipation, unidentified digestive disorders due to irrational alimentation and stressful conditions

Other Effects

A significant reduction in plasma homocysteine, a risk factor for coronary heart disease, congestive heart failure, systolic hypertension, artherothrombotic events, complications in diabetes mellitus, cancer and oxidative stress has been demonstrated in OA patients after a cycle of sulphurous thermal baths and changes in several cardiovascular risk factors in a group of patients suffering from degenerative musculoskeletal disorders subjected to a cycle of balneotherapy.

Indications for Balneotherapy:

Over the several hundred years during which the science of medical balneology has developed, physicians have been able to identify the health conditions that can best be treated by healing springs. These are examples where is balneology suggested to help.

Chronic Diseases

1. Chronic rheumatic diseases

2. Functional recovery of central and peripheral neuroparalysis

3. Metabolic diseases, especially diabetes, obesity, and gout

4. Chronic gastrointestinal diseases

5. Chronic mild respiratory diseases

6. Circulatory diseases, especially moderate or mild hypertension Peripheral circulatory diseases (affecting the hands and feet)

7. Chronic skin diseases

8. Psychosomatic and stress-related diseases

9. Autonomic nervous system dysfunction

10. Vibration disorder (a middle ear disorder affecting balance)

11. Sequela of (conditions resulting from) trauma

12. Chronic gynecological diseases

Balneotherapy in Medicine

The centers are classified as being low mineralized (0.6–2 g/l), mildly mineralized (>2–10 g/l) or highly mineralized (>10 g/l). Water temperature is described asbeing cold (30– 40°C); or hyperthermal (>40°C). The dermatological therapeutic effect would appear to lie in a local interaction between the mineral water and the structure of the skin surface.

The effects of spa therapy can be divided into three categories:

1.Mechanical

Immersion allows the patient to mobilize joints and strengthen muscles with minimal discomfort. This hydrostatic effect is increased when the water is more concentrated. Hydrostatic pressure also causes displacement of fluids from the extremities to the trunk, thus causing hemodilution and increased diuresis. It has been shown that immersion for 1 hour increases water excretion by about 50%.

2.Thermal

The hot water causes superficial vasodilation and it has been shown to reduce vascular spasm and stasis in the nail bed and conjunctiva. The in vivo proliferative response of human peripheral blood lymphocytes to phytohemagglutinin and concanavalin A was enhanced markedly when cultured

at 40°C compared with the conventional temperature of 37°C.

3. Chemical.

The solutes or additives in spa water act primarily on the skin. The composition and physical properties of various spa waters vary. They are salty, sulfurous, bicarbonated, carbonic, radon-rich, selenium-rich, arsenical and ferruginous, etc.

Dermatologic Effects

Balneotherapy using acidic hot-spring water (Kusatsu, Japan) was shown to be useful for

controlling the skin symptoms of acute flares of refractory cases of atopic dermatitis in comparison to a hot plain-water shower.

The Dead Sea is a famous place for its balneologic properties and its effects, especially on ailments of dermatologic and rheumatologic origin. The Dead Sea has a salt content of about 320 g/l, of which potassium chloride, magnesium chloride, calcium chloride and sodium chloride are the major components. The average mineral salt contents (g/l) are as follows: sodium, 5.44; potassium, 4.16; calcium, 65.28; magnesium, 15.69; chloride, 24.96; sulfate, 24.96 and carbonate, 74.24. Total concentration of salt and minerals are 32%, compared to a total concentration of 3% in the ocean. The climatotherapy regimen consisted of daily sun exposure (maximum, 3– 4 hours a day), bathing

in Dead Sea water (20 minutes twice a day) and free application of emollients.

Acute exacerbation ofatopic dermatitis must first be given specific pharmacologic treatment, however, bathing can prepare the skin for the application of moisturizers. Rest and the healthy environment provided by spas can also be positive factor in healing atopic dermatitis Acne vulgaris is another dermatologic disease that benefits from balneotherapy. Sulfur-rich spas attract special interest for their dermatologic effects. The sulfur that penetrates the skin is oxidized and evokes various physiologic responses in the skin, such as vasodilation in the microcirculation, an analgesic influence on the pain receptors, and inhibition of the immune response. Sulfur also interacts with oxygen radicals in the deeper layers of the epidermis. Sulfur and disulfur hydrogen, which may be transformed into pentathionic acid, and this may be the source of the antibactericidal and antifungal activity of sulfur water. The therapeutic action of sulfur water is related mainly to sulfur’s keratolytic effect, resulting in peeling demonstrated in both in vivo (a 5% concentration of MgCl2) and in vitro (a 1% concentration of MgCl2) studies that magnesium ions specifically inhibit the antigen-presenting capacity of Langerhans cells and may thus contribute to the efficacy of magnesium-rich spa water in the treatment of inflammatory skin diseases. Therapeutic activities of CO2 water baths (700–1300 mg CO2 per kg water) are explained by a synergism between hydrostatic pressure and the chemical properties of carbon dioxide that acts directly on the blood vessels of the skin, causing vasodilation and increased oxygen utilization.

Apart from immersion, drinking spa water has also been investigated for treatment of dermatologic conditions. Drinking of low-salt Avene (France) spring water (sodium, 4.9 mg/l; magnesium, 22.5 mg/l; calcium, 44.3 mg/l; bicarbonate, 234.8 mg/l) for a period of 18 days normalized the intestinal permeability in patients with atopic dermatitis. Drinking and immersion in a selenium-rich spa water (selenate 70 µg/l) for three weeks at the care center of La Roche-Posay (France) demonstrated an improvement in patients with psoriasis. Patients who responded to treatment had a significant increase in their plasma selenium level. In patients with psoriasis, inflammatory reactions in the skin may lead to an increased loss of selenium.

Psoriasis

The sulfur that penetrates the skin is oxidized and evokes various physiologic responses in the skin, such as vasodilation in the microcirculation, an analgesic influence on the pain receptors, and inhibition of the immune response. Balneotherapy for psoriasis is very efficacious. The addition of balneotherapy with mud packs and sulfur baths enhances the improvement observed in both the skin and joints in these patients. Bathing in high-concentration salt solutions may trigger the elution of various chemotactic and proinflammatory mediators (i.e., elastase and cytokines)

from the affected skin of patients with psoriasis.

Balneotherapy in Dental Uses

Heat Therapy Liquid heat therapy is a complementary therapy that is highly effective for the following:

1. Promotion of healing after oral surgery

2. For the treatment of infections

3. Prevention of infections during wound healing after surgery

How does it work

Heat creates higher tissue temperatures, which produces vasodilation that increases the supply of oxygen, nutrients, immune factors, antibiotics, and the elimination of carbon dioxide and metabolic waste. Increased local circulation allows antibiotics and the immune system to work more effectively . Promotes proper drainage of stagnant old blood after surgery. Local heat promotes proper drainage of infection if infection is present. Drainage is key to successful resolution of infections by Increasing local circulation.

Heat therapy:

1. Gently rinse the inside of the mouth with warm-hot Saline (1/2 Teaspoon of salt to a 12 oz glass of warm water). Do this several times a day for one week after surgery. The more frequently the better.

2. Drink hot teas (preferably herbal) and gently circulate the tea in the mouth before swallowing,

3. Do this several times a day for one week after surgery . (173-176)

**Stillwater Therapy**

traces its roots to the age-old human fascination with water’s calming properties. Ancient cultures revered bodies of water as sacred places of healing and reflection.At its core, Stillwater Therapy is built on the principle that minds mirror the environment. Immersing in calm, still waters, would project the same stillness into the thoughts and emotions. Visual exposure to water scenes also plays a crucial role. Studies have found that even looking at images of water can lower heart rate and blood pressure.

The therapeutic power of the coast has long been a source of healing and rejuvenation for those seeking respite from the stresses of modern life. The coastal therapy is the practice of using coastal

environments and their natural elements to promote physical, mental, and emotional well-being. The sea air acts as an aromatherapist, the sand as a masseuse, and the waves as a soothing soundtrack. It is a holistic approach to health that taps into the primal connection with the ocean, harnessing its power to heal and restore. The concept of coastal healing is as old as the tides themselves. Ancient Romans recognized the restorative properties of seawater, In the 18th and 19th centuries, European doctors frequently recommended “sea cures” to their patients, believing that the coastal climate could treat everything from tuberculosis to melancholy.

The concept of “blue space theory” suggests that being near water – be it oceans, lakes, or rivers – has a positive effect on the mental health and well-being. The color blue itself is associated with feelings of calm and serenity, and researchers have found that people living near coastal areas report better overall mental health and lower stress levels. Thalassotherapy, known as saltwater therapy is a coastal treatment, using seawater and marine products for therapeutic purposes. The rhythmic lullaby of crashing waves and the gentle caress of salty air hold an ancient secret—a transformative power that mends the mind, invigorates the body, and soothes the soul.

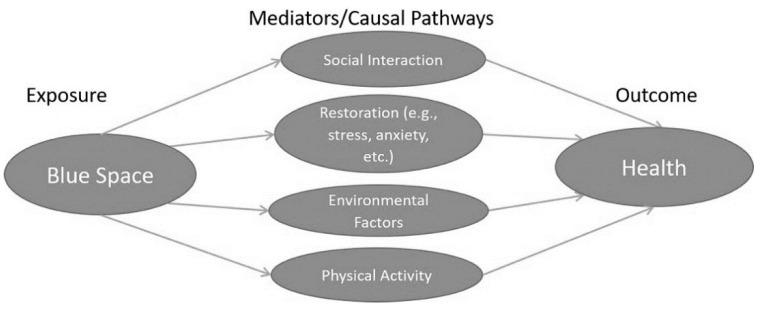


Fig.23. Blue Space-Hypothesized health mediators/casual pathways.

Coastal and marine waters provide various goods, services, and cultural benefits that impact economic systems and human well-being. Surface water bodies, such as rivers, lakes, and streams, and the ecosystem services provided by these freshwater bodies are vital for sustaining life cycles, social processes, and economic prosperity. Historically, water resources have been important for human civilization. When increased attention is being given to the therapeutic landscapes within a city, blue space offers health-enhancing qualities. Blue space has been defined as a natural or manmade outdoor environment that prominently features water and is proximally (being in, on, or near) or distally/virtually (being able to see, hear, or sense water) accessible to humans.

The presence of natural environments plays a role in promoting physical and mental health in urban neighborhoods. The terms “natural environment” and “nature” have been used interchangeably in describing the physical properties of things of a nonhuman origin, including flora and fauna together with still and flowing water, weather and air qualities, and landscapes. Exposure to green spaces and blue spaces has been reported to promote human well-being and mental health. The health benefits of green spaces confirmed via meta-analysis include increased high-frequency heart rate variability (HRV), a higher incidence of self-reported good health, decreased low-frequency HRV, salivary cortisol, diastolic blood pressure, heart rate, and high-density lipoprotein cholesterol levels, and a lower risk of preterm birth, type II diabetes, cardiovascular mortality, and all-cause mortality. Salutogenic health benefits of blue spaces are comparable to the health-promoting features of green spaces that are associated with decreased obesity levels and all-cause mortality and improved self-reported general health, mental health, and well-being.

The definition of green space encompasses open areas of vegetation, conservation areas, and any spaces predominantly covered by vegetation, such as parks, sports fields, forests, backyard gardens, and farms, whereas blue spaces are all the visible surface waters in an area, such as rivers, lakes, and coastal waters. Blue space, which might includes trees and other vegetation, is more referred to as a water environment. The unique characteristics of liquid and the movement of water are associated with a sense of mobility, capturing people’s minds and senses, and affecting physical activities.

A qualitative interview study of older adults reported that blue spaces are noteworthy for their impact on spiritual restoration and mental well-being, whereas green spaces are important for social interaction and social well-being and frequently visiting blue spaces such as rivers, canals, and seas leads to greater mental well-being, whereas frequently visiting green spaces alone leads to a higher likelihood of reporting good general health. The term blue space, that is not a subcategory of green space, has been used interchangeably with the terms “blue infrastructure” and “water bodies. A prominent theory of natural preference, the biophilia hypothesis, explains that humans are innately attracted to nature because of genetic makeup and biological evolution.

Beach therapy, in its simplest form, is the practice of using the coastal environment to improve physical and mental well-being. From the negative ions in the air to the vitamin D-rich sunshine, the beach offers a natural pharmacy of sorts, that has been quietly working its magic for millennia. From ancient seas to modern spas, the healing power of saltwater has been harnessed for centuries, offering a natural remedy for both body and mind. Dockside therapy is a novel approach to mental health treatment that combines traditional therapeutic techniques with the natural healing properties of waterfront environments. (177-179)

**Deep sea water (DSW)**

refers to a body of seawater that is pumped up from a depth of over 200 m. It is associated with the following characteristics: low temperature, high purity, and being rich with nutrients, namely, beneficial elements, which include magnesium (Mg), calcium (Ca), potassium (K), chromium (Cr), selenium (Se), zinc (Zn), and vanadium (V). Less photosynthesis of plant planktons, consumption of nutrients, and organic decomposition have caused lots of nutrients to remain there. DSW has potential to become a good source for health. Research has proven that DSW can overcome health problems especially related to lifestyle-associated diseases such as cardiovascular disease, diabetes, obesity, cancer, and skin problems. Its location being far from solar radiation results in it having minimal to no bacteria activities. Less photosynthesis of plant plankton, consumption of nutrients, and lots of organic decomposition causes abundant nutrients to remain there. The abundance of inorganic material becomes higher when the depth of the seawater is increased. Water is generally defined as a liquid which is shaped by the container that it is filled in and is able to have many variants of colours. It is the crucial component for all living things.

Humans need water for many functions such as to regulate body temperature, enhance body metabolism, and provide minerals that are essential to the body. There are many sources of water, such as surface water, aquifer, spring, and seawater. People usually consume drinking water that is in the form of bottled drinking water (such as mineral water), filtered tap water, or boiled tap water. Drinking water sold by suppliers is expected to contain good nutrient content and be safe to be consumed, because the suppliers possess a production license from the authorities.

Some drinking water available in the market has been reported to have low mineral content due to the common process that drinking water undergoes such as reverse osmosis and filtration, which removes the mineral contents inside it. Mineral water, which does not undergo the extensive process needed, is completely taken from groundwater and gains mineral ions from its sources such as rocks. It is also reported to contain low minerals. The mineral contents in the water varies with the geographical locations and the treatment process that it has gone through.

DSW can offer plenty of minerals for the production of drinking water, and other DSW by-products. The production of refined DSW usually involves a desalination process, followed by a mineralization process. A high concentration of mineral salts in DSW though will commonly be processed through means such as reverse osmosis, electrodialysis, or low vacuum temperature in order to produce a safe concentration of water for consumption. DSW is more abundant in minerals compared to surface seawater. DSW is a good nutrient source and provider, since the minerals contained inside provide many benefits to health.

Mg is significant for many physiological processes in the body such as for energy metabolism and enzyme functions, reducing lipids accumulation in the aorta of subjects that has high cholesterol intake, and dilating the blood vessels and stopping spasms in the heart. It is also able to reduce the risk of obesity, diabetes, and asthma. Drinking water, which has high Mg content, has shown higher inhibitory effects in the adipocyte differentiation, which means that the synthesis of fat cells is able to be slowed down by Mg.

Ca is one of the major minerals for humans. It has many benefits to health such as for bone development and density and acts as the pivotal cofactor for several enzymes needed for energy metabolism. Adequate intake of Ca reduces the risks of cardiovascular disease, obesity, and some forms of cancers. A high Ca diet is able to increase lipolysis and preserve thermogenesis during caloric restriction, in a way that markedly accelerates weight loss. Cr is an essential nutrient that is required for carbohydrates and lipids metabolism. It has antioxidant properties which are useful for expanding cell life. V has the potential for reducing lipids and has shown effectiveness in inhibiting adipocyte differentiation of the fat cells.

The most promising benefits that can be attained from DSW intake are that it is able to improve the cholesterol profiles in the serum and liver, respectively. Its applications have reduced the levels of triglyceride (TG), non-high-density lipoprotein cholesterol (non-HDL-C) levels, and total cholesterol (TC) in the serum and liver of animal models, respectively. Drinking water produced from DSW which contains Mg of 600 and 1000 ppm, is able to decrease cholesterol levels by 18% and 15%, respectively. A study of DSW consumption by hypercholesterolemic individuals proved that it could reduce TC and low density lipoproteins (LDL) and decreased lipid peroxidation in those subjects. The mechanisms for the improvement of cholesterol profiles are associated with the upregulation of hepatic low density lipoprotein receptor and cholesterol-7a-hydroxylase (CYP7A1) gene expressions, which are involved in cholesterol catabolism. A DSW intake resulted in a higher faecal cholesterol and bile acid excretions, thus decreasing the TC levels. DSW decreases the lipid contents of hepatocytes through the activation of AMP-activated protein kinase, inhibiting the synthesis of cholesterol and fatty acid.

DSW provides protection from cardiovascular diseases by decreasing the TC, TG, atherogenic index, and malondialdehyde (MDA) levels, while increasing the serum trolox equivalent antioxidant capacity (TEAC). The molecular mechanism of its cardiovascular protection is via upregulation of hepatic low density lipoprotein receptors (LDL receptors) and CYP7A1 gene expressions. The cardioprotective effects were proven, when its application can reduce abnormal cardiac architecture and apoptosis and enhance insulin-like growth factor-1 receptor (IGF-1R) cardiac survival signalling. Atherogenesis is the formation of plaque in the inner lining of an artery, which deposits fatty substances, cholesterol, cellular waste products, calcium, and other substances. Treatment with DSW was able to prevent the atherogenesis process. DSW with the hardness of 300, 900, and 1500 had significantly decreased the atherogenic index [(TC − HDL-C)/HDL-C] .

DSW has antiatherogenic properties due to the existence of many beneficial mineral ions such as Mg and Ca in it. Antiatherogenic effects of DSW are associated with 5-adenosine monophosphate-activated protein kinase (AMPK) stimulation and the consequent inhibition of phosphorylation of acetyl-CoA carboxylase (ACC) . AMPK plays an important role in lipid metabolism via the inhibition of 3-Hydroxy-3-methyl-glutaryl-CoA reductase (HMGCR) and ACC and then inhibits the production of cholesterol. Prevention of atherogenesis may avoid severe health problems, including coronary heart disease and stroke by enhancing cardiovascular protection. DSW improves cardiovascular hemodynamics and reduce blood pressure.

Hypertensive rats that were treated with DSW for eight weeks had lower blood pressure than the control group. Reduced fats and blood lipids, such as in the artery, may be associated with the reduced blood pressure. Although DSW used in the study contained pretty much salt, the blood pressure did not increase. Lots of minerals combination in the DSW, such as Mg, Ca, and Na are associated with a reduced blood pressure. Na content may induce hypertension, though Mg supplement might lower the blood pressure by suppressing the adrenergic activity and natriuresis. HHHhLLigh Mg content can lower blood pressure in the presence of sodium.

DSW has antiobesity properties and reduces fat and body weight. The research has reported that DSW was significantly able to reduce lipids accumulation in the in vitro and in vivo models. The antiobesity activities are mediated by modulating the expression of obesity-specific molecules. The expression of key adipogenic genes such as peroxisome proliferator-activated receptor-*γ* (PPAR*γ*), CCAAT/enhancer-binding protein-*α* (C/EBP*α*), and adipocyte protein-2 (aP2) was suppressed, and the expression of glucose transporter 4 (GLUT4) was increased by its application and mitochondrial biogenesis, the component which controls the release of energy associated with lipid metabolism, was stimulated. Mg and Ca ions, as the main active components , reduce fats.

DSW is also able to treat diabetes by improving glucose intolerance and suppressing hyperglycaemia. Its application recovers the size of the pancreatic islets of Langerhans and increase the secretion of glucagon and insulin. Through quantitative reverse transcription polymerase chain reaction, DSW showed improvement regarding the expression of hepatic genes involved in glycogenolysis and glucose oxidation. DSW increased, glucose uptake, *β*-oxidation, and glucose oxidation in muscles, and the phosphorylation of IRS-1, LKB1, AMPK, and mTOR, which are signalling molecules related to lipid and glucose metabolism. Blood glucose in treated mice was reduced by its application. The plasma glucose levels in DSW-fed mice were substantially reduced by 35.4%, compared to the control mice group. Its antidiabetic properties are associated with the existence of mineral ions such as Mg and Ca. DSW is also capable of treating skin problems. In a study involving patients with atopic eczema/dermatitis syndrome (AEDS) treated with DSW, the improvement of skin symptoms such as inflammation, lichenification, and cracking of the skin was observed. AEDS patients typically exhibit an imbalance of various essential minerals in hair, and some have toxic minerals present. DSW intake has restored the essential minerals such as Se and reduces the levels of toxic minerals such as mercury and lead in the treated patients.

In another study, the intake of DSW has reduced allergic skin responses and serum levels of total IgE, Japanese cedar pollen-specific IgE, interleukin-4 (IL-4), IL-6, IL-13, and IL-18 in the patients with allergic rhinitis, compared to the distilled water intake which fails to give those effects . In vivo study revealed that DSW can recover the atopic skin lesion by improving the skin symptoms such as edema, erythema, dryness, itching, transepidermal water loss (TEWL), decreased epidermal thickness, and infiltration of inflammatory cells. Its application can reduce allergic responses when reduction of total IgE levels and histamine released were recorded. It also inhibited upregulation of IgE, histamine, and proinflammatory cytokines (tumor necrosis factor *α* (TNF-*α*), IL-1*β*, and IL-6) in the serum.

High fat diets may cause problems to hepatic systems. DSW is able to give protection for hepatic problems decreasing the lipid accumulation in livers, which are associated with the increase in daily faecal lipid and bile acid outputs. DSW was able to regulate hepatic fatty acid homeostasis by upregulating genes related to b-oxidation of fatty acids, which are hepatic peroxisome proliferator-activated receptor-alpha, retinoid X receptor-alpha, and uncoupling protein-2 gene expression. Its application can attenuate hepatic damage, which is proven by reduced lipid peroxidation status in livers, which might be related to reducing hepatic malondialdehyde (MDA) content. The liver damage indices which are aspartate aminotransferase (AST) and alanine aminotransferase (ALT) are also reduced by its application.

DSW can restore fatigue and improve exercise workload. Its application has promoted the endurance and reduced exhaustive period of rats in an exercise test. The ratios of lactic acid elimination to lactic acid increment were improved in DSW treated rats. Study regarding effects of DSW on human shows significant findings as well. DSW is able to accelerate recovery from physical fatigue of people, following an exhaustive physical challenge. The findings suggested that DSW which has enriched contents of boron, magnesium, lithium, and rubidium may complement and enhance the molecular and cellular complexity of human during exercise, eradicate exercise-induced muscle damage, and strengthen antioxidant capability against oxidative stress.

DSW can reduce ulcer area as well as apoptotic signalling in acetic acid-induced duodenal ulcers. It had upregulated antioxidant and enhanced Bcl-2 and thioredoxin reductase 1 expression in a study that used rats. In that study, DSW ingestion provided intestinal protection via the antioxidant and antiapoptotic mechanisms of selenium. DSW is potential to prevent cancer. Its application can inhibit human breast cancer cell lines' migratory ability in a wound-healing assay. DSW has also promising effects on antibacterial activity. The findings of its antibacterial activities were proven in the studies using the in vitro, in vivo, and clinical model. DSW application can delay cataract development. This effect is associated with the presence of Mg and Ca content in DSW.

DSW has therapeutic potential on osteoporosis. DSW at hardness 1000 showed significant increase in proliferation of osteoblastic cell (MC3T3). In the in vivo study that uses DSW for 4 months, bone mineral density (BMD) was strongly enhanced followed by the significantly increased trabecular numbers through micro-CT examination. Biochemistry analysis showed that serum alkaline phosphatase (ALP) activity was decreased. The results demonstrated the regenerative potentials of DSW on osteogenesis, showing that it could potentially be applied in osteoporosis therapy as a complementary and alternative medicine (CAM). (180)

**ENERGETIC MIND-BODY MEDICINE**

The question of whether the mind may or may not influence matter is of relevance, especially within a dialogue of conflicting cultural, religious, and scientific concepts. Common terms used in the field of energy healing include *energy healing*, *energy medicine*, *energy therapies*, *laying on of hands*, and *spiritual healing*  There is a great deal of cross pollination within and across traditions.

Key tenets of a worldview healing would include:

* the existence of a universal life force or vital energy flowing through and available to all beings;
* the existence of a subtle energy system or biofield that interpenetrates the physical anatomy of the human body and extends outward beyond it;
* the idea that in ill health, the human energetic field is out of balance or congested, free flow is blocked, which diminishes the normal self-healing capacity;
* the belief that the practitioner can detect abnormalities in the energy system, sometimes before physical manifestations, and restore the capacity for self-healing;
* the contention that the practitioner's conscious healing intent and compassion are essential to the effectiveness of therapy; and

The healer claims to be connected or come into resonance with a source of healing such as divine love, the universal life force, or the earth's energy and channeling this energy from outside the self or acting as facilitator or conduit of this energy to help others by sending the flow of that energy. The healer might think to have have innate sensibilities or unusual experiences accompanied by personal introspection, growth, and ultimately transformation to embody wholeness, practicing self-care physically, mentally, and emotionally, and commit to self-management of the ego and motivations.  Lived experiences bring the healer to a “radical empathy,” with an ability for deep connection to others and desire to alleviate their suffering.

There is general consensus across disciplines that 3 major states within the healer are paramount to effective healing: compassion, focus, and intention. Compassion involves unconditional love, a desire to help, a deep caring, and a shared humanity. Focus includes authentic presence; concentration; being centered, grounded, and relaxed; getting the self out of the way; reaching a mental stillness where the healer is aligned with the energy source, open and sensitive to altered perceptions. The third essential state includes intention. Since healing is a consciously focused activity, a more useful term  *volition or even will may replace intention*. The process becomes kinesthetic as energy moves. Healing means the transfer of energy from one field to another as well as sometimes physically manipulating the other’s body with energy. The concept of focus encompasses a shifting state of consciousness from a concentration and access to spiritual entities, intuition, multiple realities, or experiences of the world of spirit, ineffable sensations, altered perceptions, and transcendence.[https://pmc.ncbi.nlm.nih.gov/articles/PMC4654782/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4654782/#R6)

 In electroencephalography (EEG) studies of healer-healee dyads, the healer's brain shifts to alpha waves and the healee's brain shifts to the same wave state In some forms of healing, heart rate variability shifted to a more aroused state during healing activity. This shift of consciousness and physiology within the healer appears to be linked to the healing. In a study, paired recordings of the healer and subject were done both with the subject at a distance and in the proximity of the healer. The EEG data were analyzed for cross-spectral coupling using the bispectrum, as well as the more traditional Fourier-based spectral analysis and EEG waveform analysis looking at phase. The healer's EEG data showed harmonic frequency coupling across the spectra, followed by between-individual EEG frequency entrainment effects, and then by instantaneous EEG phase locking. These results suggest the presence of a connection between the healer and subject.  Participants learn the process of giving up control, letting go of fear, developing courage, preparing self, engaging in self-reflection, and developing confidence. Healers need a basic background in energy anatomy as well as physical anatomy and physiology. The trained healer learns to channel and turn the flow of energy on and off with accuracy. The call for compassion and intention highlights the importance of relationship within the healing encounter. Energy healing is a complex intervention encompassing significant heterogeneity of healing practice, with dependence on the state of the healer, the healee, and their relationship.

Healing is to make whole, so measured outcomes must go beyond physiology and attempt to document transformation in cognitive, emotional, social, and spiritual domains as well. Practices of traditional medicine vary greatly with country and region, as they are influenced by factors such as culture, history, personal attitudes and philosophy. In many cases, the theory and application of traditional medicine are quite different from those of conventional medicine.

Traditional medication involves the use of herbal medicines, animal parts and minerals. Non medication involves various techniques including, acupuncture and related techniques, chiropractic, osteopathy, manual therapies, qigong, yoga, and other physical, mental, regimental, spiritual and mind-body therapies. , primarily without the use of medication.

The idea that thoughts and emotions influence health outcomes is an ancient concept that was initially abandoned by Western medicine researchers. Today, researchers are showing a renewed interest in the interactions of the mind and body and the role these interactions play in disease formation and recovery. Complementary and alternative interventions, such as mind-body therapies, are increasingly being used by cancer survivors for disease prevention, immune system enhancement, and symptom control.

Traditional training has not been structured to provide advanced practitioners with an in-depth knowledge of the clinical applications of mind-body therapies. Mind and body practices, that are complementary health approaches, aiming at reducing anxiety, mood disturbance, pain and improving QOL , focus to promote health and well-being by enhancing the ability of the mind to regulate the physical body for optimal daily functioning and alter physical function and promote overall health and facilitate brain-behavior interactions among the brain, body, mind, and behavior enhancing the ability of the mind to regulate the

Mind–body exercise (i.e., Tai Chi, qigong and yoga) is a specifc type of practice that incorporates meditation into the execution of movement routines to improve body balance and the fexibility and strength of the musculoskeletal structures. Unlike conventional physical exercise that specifically emphasizes the awareness of bodily movements, mind–body exercise emphasizes the coordination between breathing, bodily sensation awareness, and bodily movement execution.

Understanding the brain’s cognitive function depends on the knowledge of how neural units interconnect both locally, within distinct brain regions, and at the large scale of the whole brain. Balance between localized processing and global integration provides support for the complex processing patterns, underlying high-order cognitive function, while at the same time ensuring flexibility, robustness, and functional diversification in the brain.

The network paradigm enables a theoretical framework for investigating interactions between brain regions as well as the use of powerful computational tools for interpreting the complex topology of functional networks.

Seven functional networks included

the default mode network (DMN; coordinates other task-positive networks),

somatomotor network (SMN; for motor control and execution),

frontoparietal network (FPN; coordinates goaldirected behavior),

dorsal attention network (DAN; for top-down attention control),

ventral attention network (VAN; detects salient stimuli),

limbic network (LIM; for emotional processing), and

visual network (VIS; processes incoming visual information).

The basal metabolism of the human brain measured during rest state (i.e., eyes closed, awake, and no specific cognitive task) represents 20% of the total body energy consumption. Mind–body exercise modulates functional connections in the brain at rest, as evidenced by changes in correlations of blood-oxygenation-level dependent (BOLD) signals between brain regions, regional homogeneity and nodal efficiency measured by functional magnetic resonance imaging (fMRI). General fitness served as a neuroprotective factor in older adults evidenced by both maintenance of BOLD signals during updating in prefrontal cortex and in other regions implicated in cognitive control (right precentral gyrus, left cerebellum/ and bilateral superior parietal lobule). Along with a positive correlation between task accuracy and the BOLD signal activation compensatory brain regions, certain lifestyle factors, including prolonged physical activity, enhance available neural resources which can reduce the effects of age-related cognitive declines.

The beneficial effects of physical activity are related directly to angiogenesis, neurogenesis in hippocampus and synaptogenesis, growth factor gene expression and upregulation of anti-inflammatory processes as well as to indirect improvements in cardiovascular health ( lower resting heart rate and blood pressure, improved state of blood vessels, increased cerebral blood flow (CBF); , lower incidence of cardiovascular disease and overall mortality. Physical activity has been also related to decreased stress, anxiety, and depression, as well as improved circadian rhythm regulation (i.e., better sleep) through modulation of the serotonergic system and the dorsal raphe and suprachiasmic nuclei in particular.

It is also worth noting the relationship between physical activity or cardiorespiratory fitness and brain function measured by methods other than fMRI. Electroencephalographic (EEG) studies of event-related potentials (ERPs) provide evidence of compensatory or maintained neural function during cognitive control tasks of working memory, task-switching), and inhibitory control in high fit older adults. The studies showed that superior cognitive control function in highly physically active older adults is related to lower P3 (P300) latency in the frontal and parietal electrodes, compared to older adults engaging in low levels of physical activity. The P3 wave has been implicated in the modulation of attentional control over the processes engaging working memory, including updating.

Fitness is associated with compensatory overactivations in the left parietal and occipital areas during sustained activation related to proactive control in older adults but, these regions are not significantly engaged in younger adults. BOLD signal in these regions showed a positive relationship with task: accuracy, older adults, underactivated right parietal and occipital regions while younger adults activated in during the task. It means that high fit older adults are able to activate regions contralateral to task-sensitive regions and protective effects of physical fitness on cognitive control, with strenuous physical activity maintain, and even compensate for the decline of cognitive and brain functions in older age. Moreover, some age-related differences in brain functions were attenuated among the highly fit older adults.

The specifity refers to the degree to which neural representations of different stimuli can be distinguished. Evidence suggests that neural specificity , defined as stimulus- related differences in functional magnetic resonance imaging (fMRI) activation patterns , declines with advancing adult age. Thus, regular physical activity preserves cognitive abilities in old age. Pictures of faces, houses, and many other stimulus categories elicit distinguishable patterns of neural response in ventral visual cortex (VVC) using functional magnetic resonance imaging (fMRI). Evidence suggests that neural specificity declines with increasing age and reduced neural specificity is associated with lower cognitive performance in a variety of cognitive tasks in older adults.

Age-related declines in neurotransmitter function and neuromodulation have been suggested as underlying mechanisms, since the number of dopamine (DA) neurons, as well as DA receptor levels show pronounced and widespread decrements with advancing adult age. Neurocomputational models predict that attenuated neuromodulation lowers a cell’s responsivity and leads to less differentiated neural responses to different stimuli (i.e., less distinct neural representations), which in turn would explain age-related deficits across a wide range of cognitive domains.

On the other hand, regular physical activity has repeatedly been shown to preserve cognitive abilities in old age. Evidence from animal research suggests that exercise induces an upregulation of DA, possibly by stimulating DA synthesis through a calcium/calmodulin-dependent system. Consistent with this hypothesis, [https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2017.00123/full](https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2017.00123/full#B28) increased plasma concentrations of DA were found after 6 months of physical training in older humans. Moreover, young adults with a genotype associated with lower DA levels (val/val COMT gene homozygotes) exhibited greater cognitive improvements after a 4-month exercise intervention compared with other genotypes (met carriers).

Since the relationship between DA and cognitive performance seems to follow an inverted U-shape, exercise may optimize central DA availability. Similarly, a cross-sectional study with older adults showed that val/val homozygotes benefitted most from better fitness in terms of Flanker task performance. Research suggest that neural specificity provides a potential mechanism for beneficial effects of exercise in preserving cognitive functions in older adulthood.

Regarding fMRI, exercise –induced fitness changes were found to induce improved neural efficiency (reductions or stability of BOLD activation in task relevant areas as well as strengthened functional connections in relation to default mode and frontal executive networks. Changes in neural efficiency and specificity can ocur independently from each other. Specifically, exercise tarining lead to neural representations that achieve greater distinctiveness with a lower levels of activation. Exercise has been found to change brain perfusion to affect non-hippocampal cortical blood flow and volume, as the fMRI BOLD signal measures a vascular response.

The term “negative BOLD response” is used to describe a BOLD decrease in response to a stimulus that in fact elicits a decrease in neural activity. Depending on the interaction between metabolism and hemodynamics, diminished BOLD signals can reflect high neuronal activity, with blood flow not adequately rising to match oxygen consumption. A negative change next to a positive change of BOLD signal in adjacent brain regions has been attributed to reallocation of cortical blood.

Mind–body exercise might promote the readiness to perform goal-directed tasks of an individual and modulates the functional connections of dorsal (DAN) and ventral (VAN) attention networks at rest. While the DAN, a network that exerts top-town control, is responsible for regulating the processing of external stimuli in facilitation of the successful engagement of goal-directed behavior, the VAN is a “bottom-up” network that is responsible for the detection of behaviorally relevant stimuli. These two networks interact with each other during attention shifing; specifcally, the VAN interrupts the activation of DAN to allow an individual to reorient his attention to a new external stimulus. The upregulation of DAN and downregulation of VAN at rest may imply that mind–body exercise reduces the reactivity towards external stimuli while also enhancing the ability to focus on goal-directed behaviors and modulates brain activation patterns in the frontal cortex and functional connectivity between frontal and other brain regions. when individuals perform cognitive/afective tasks. The effect of abnormal frontal lobe activation patterns on behaviors has been extensively studied in individuals with multiple neurodevelopmental, neuropsychiatric and neurodegenerative diagnoses, such as autism, depression, and dementia.

Mind–body exercise appears to alter brain activation patterns specifically in the prefrontal brain regions, which signifes its applicability as a treatment for patients with frontal abnormalities. Clinical studies have provided positive empirical evidence supporting its applications. Short-term Qigong and long-term mind–body exercise increase gray matter volume in various brain regions, including the frontal, temporal and occipital lobes, as well as limbic and parahippocampal areas and cerebellum. These brain regions are involved in various cognitive processes, which have been shown to shrink with increasing age, and the reduction in volume is associated with age-related functional decline. Long-term mind–body practice reverses age-related neural degeneration, implying that these exercises may play a role in delaying aging in the general population. .

Mind–body exercise is a form of multicomponent exercise that combines movement sequences, breathing control, and attention regulation, which is different from traditional physical exercise. It is also referred to as movement-based contemplative practice or mindful movement, which emphasizes moving mindfully, commonly including Tai Chi Chuan (TCC), Qigong, and yoga. TCC is a form of mind–body exercise incorporating physical, cognitive, social, and meditative components. Qigong involves a set of relatively slow exercises through coordinated physical movements, breathing, and meditative state to cultivate one’s internal energy called “Qi” to achieve body healing, and Baduanjin (BDJ) is one of the most common forms of Qigong.

Yoga is an ancient mind–body exercise which focuses on the present moment, consisting of physical postures (asanas), control of breath (pranayama), and the use of meditation (dyana), and the most common form is Hatha yoga. Compared with aerobic or resistance exercise, mind–body exercises are relatively low in intensity and slow in pace, particularly suitable for the elderly and groups with chronic diseases. (181-194)

**BALANCE BOARD THERAPY (BBT)**

At its core, balance board therapy involves the use of specially designed boards that create an unstable surface, challenging the user to maintain equilibrium while performing various exercises or tasks. These boards come in different shapes and sizes, each offering unique benefits and challenges. The roots of balance board therapy can be traced back to the mid-20th century when physical therapists began experimenting with wobble boards to help patients recover from ankle injuries.

1. Wobble Boards: These are balance boards, featuring a flat surface top and a dome-shaped base. Wobble boards are fantastic for improving ankle stability and are particularly useful for those recovering from ankle sprains or looking to prevent future injuries.
2. Rocker Boards: These boards tilt along a single axis, allowing for forward and backward or side-to-side movement. They are great for targeting specific muscle groups and used in rehabilitation programs for knee and hip injuries.
3. Multi-directional Boards: They allow movement in all directions, providing a more challenging and comprehensive workout. Athletes use them for sport-specific training, since they mimic the unpredictable movements encountered in many sports.
4. Spinning Boards: These circular boards rotating 360 degrees, are used to improve coordination and spatial awareness.

Benefits of balance board therapy are as diverse as the boards themselves. Some of the key advantages:

1. Improved Proprioception and Body Awareness: Proprioception is the body’s ability to sense its position in space. It is like the internal GPS system. Balance board therapy helps fine-tune this system, making more aware of the body’s movements and position. This improved body awareness can translate to better performance in sports, reduced risk of falls, and improved overall movement quality.
2. Enhanced Core Strength and Stability: The constant need to maintain balance engages the deep abdominal muscles, lower back, and pelvic floor, leading to improved core strength and stability, from better posture to reduced lower back pain.
3. Better Balance and Coordination: Regular use of a balance board can significantly improve overall balance and coordination.
4. Injury Prevention and Rehabilitation: Balance board therapy is a powerful tool for both preventing injuries and aiding in recovery. By improving joint stability and muscle strength, it reduces the risk of common injuries like ankle sprains. For those already dealing with injuries, balance board therapy can be an effective part of the rehabilitation process, helping to restore function and prevent future issues.
5. Cognitive Benefits and Neuroplasticity: Balance board therapy doesn not just work to the body, it also gives to the brain a workout too. The challenge of maintaining balance on an unstable surface engages multiple areas of the brain, promoting neuroplasticity – the brain’s ability to form new neural connections, which lead to improved cognitive function, better reaction times, and even enhanced memory.

Balance board therapy, not just for athletes or fitness enthusiasts, is a valuable tool in treating a variety of conditions:

1. Ankle Sprains and Instability: Balance boards help to improve proprioception and strengthen the muscles around the ankle, reducing the risk of future sprains and improving overall stability.
2. Knee Rehabilitation: For those recovering from knee injuries or surgery, balance board therapy can help to improve joint stability and muscle strength around the knee.
3. Lower Back Pain Management: By strengthening the core and improving overall posture, balance board therapy can be an effective tool in managing chronic lower back pain like giving to the spine a support team.
4. Vestibular Disorders and Balance Issues in Older Adults: Balance board therapy can be particularly beneficial for older adults or those with vestibular disorders. It helps improve overall balance and reduce the risk of falls, which can be life-changing for many seniors.
5. Post-Stroke Balance Recovery: For stroke survivors, regaining balance can be a crucial part of the recovery process. Balance board therapy can help retrain the brain and body to work together, improving overall stability and independence.

Offering a wealth of benefits for a wide range of individuals from improving physical stability and strength to enhancing cognitive function, balance board therapy has proven itself to be a versatile and effective tool in the worlds of rehabilitation, fitness, and overall wellness. Whether recovering from an injury, looking to enhance an athletic performance, or simply to improve overall balance and stability, balance board therapy offers a fun and effective way to challenge the body and mind. Virtual reality integration, smart balance boards that can track and analyze the movements, and even more specialized boards for specific conditions or sports are all on the horizon. (195-201)

**Alıgnment therapy**

There is general agreement that good postural alignment is also an important element in optimizing voice function. The Golgi tendon organs are the primary mechanism by which muscle tissue is released during a static stretch. These proprioceptive stretch receptors respond to intentional prolonged stretch and inhibit the contractile response of the muscle spindles via the inverse stretch reflex. The Golgi tendon organs require approximately 6 seconds to initiate their response to a muscle stretch. More time is required for the muscle to relax to its full length.

Overstretching of muscle that results in pathological muscle lengthening increases an individual’s susceptibility to injury as an overcompliant muscle-tendon unit results in decreased sensitivity of the Golgi tendon organ. In addition to considering the pattern of muscle tension and weakness, it is important to consider body type, specifically whether the patient has ‘‘lax’’ connective tissue, a condition called benign generalized ligamentous laxity. Those with lax body types can be identified by their greater than normal range of motion in their joints. In this population, strengthening of major muscle groups is largely considered to be the most appropriate intervention and large amounts of stretching should be avoided. Postural assessment provides a foundation for the state of the tonic balance in the musculature.

Postural alignment is the arrangement of the body segments analyzed in different postural positions Normal postural alignment involves a minimum amount of stress and tension, providing musculoskeletal balance, which may promote maximum efficiency of the body . On the other hand, postural misalignment may be harmful to the efficiency of the musculature, aesthetically unpleasant, cause pain, discomfort, or disability, and lead to a neurological and musculoskeletal pathological condition

The three most common postural malalignments are:

kyphosis-lordosis posture,

This represents an increase in all the natural curves of the spine such that there is an increase in the cervical and lumbar lordoses (ie, exaggerated forward curvature) and in the thoracic kyphosis (ie, abnormal rearward curvature of the spine). Increased thoracic kyphosis is thought to be the most common form of spinal malalignment. This posture is commonly referred to as the ‘‘forward head posture’’. In side view, the plumb line will be posterior to the lobe of the ears and the shoulder joint; posteriorly, the midline of the head and the spinous processes of the cervical spine will be shifted anteriorly.

Flat back posture A side view shows the ears anterior to the plumb line and a decrease or flattening of the normal thoracic kyphosis and the lumbar lordosis.

Sway back posture This posture is similar to the lordosis-kyphosis posture, but there is less exaggeration of the cervical and thoracic curves. The greater difference is in the position of the pelvis, which is held in more of an anterior tilt with the knees in hyperextension.

Exercises are indicated for the prevention and treatment of postural disorders, considering the idea of strengthening the weak and lengthened part of the musculature and stretching the short and strong part. However, it is important to know the type and amount of exercise shown to be effective in the improvement of postural dysfunctions.The main deformities in the sagittal plane related to the spine are the forward head posture (cervical lordosis), thoracic kyphosis and lumbar lordosis (cervical lordosis). Still in the same plane, a rounded shoulder posture may occur, also known as protracted shoulder. In the frontal plane, the most common deformity is scoliosis, which can be with shoulder and pelvic asymmetry. The main lower extremity disorders include flat/arched foot, supinated/pronated foot, genu valgum/varum, and knee hyperextension.

In the whole-body alignment, sagittal body misalignment and frontal body misalignment are observed.There are several interventions for postural misalignment, such as braces, taping, or casting, which are devices that apply corrective forces to an isolated area of the body or cause a reduction in the musculature through immobilization. When the postural misalignment is very severe, surgery may be performed. In case of prevention or attempting postural misalignment correction, physiotherapy and exercises are recommended. Taking into consideration the idea that in misalignment, the muscles may be shortened or lengthened, the role of the exercises would be to stretch the shortened and strong musculature and to strengthen the lengthened and weak musculature.

Forward head posture (FHP) is characterized by anterior inclination of the head causing a hyperextension of the upper cervical spine (C1 – C3) , associated with the shortening of the upper trapezius, posterior cervical extensor muscles (semispinalis, splenius, and suboccipital), sternocleidomastoideus, and levator scapulae muscles, while also resulting in the weakening of the deep cervical short flexor muscles. From nagging aches to chronic pain, the secret to unlocking the body’s true potential lies in the transformative power of postural alignment therapy. If the body is considered as a finely tuned instrument, when everything is in harmony, then the body would play a symphony of health and vitality, but with misaligned notes makes dealing with a cacophony of discomfort.

Postural alignment therapy is like a skilled conductor, bringing the body back into perfect harmony. This holistic approach to wellness focuses on realigning the entire body, from the tips of toes to the crown of the head. It’s about creating balance, reducing strain, and allowing the body to function as nature intended. Ancient yoga practices emphasized the alignment of the spine, and traditional Chinese medicine has long recognized the connection between posture and overall health.

Formun Altı

At its core, postural alignment therapy is all about understanding the intricate dance of bones, muscles, and connective tissues that keep upright. It’s like a complex game of Jenga – moving one piece out of place makes the whole structure unstable.

Postural imbalances include forward head posture, rounded shoulders, an exaggerated lower back curve, and uneven hips. These might seem like minor issues, but over time, they can lead to chronic pain, reduced mobility, and even impact your internal organs. By addressing these imbalances, alignement therapy aims to bring the body back into harmony. It’s not about forcing the body into a rigid, military-style posture. Instead, it’s about gently guiding the body back to its natural, balanced state. (202-203)

**VİBRATİONAL RESONANCE THERAPY (VRT).**

Vibration therapy, which is a rehabilitation method that uses mechanical oscillations or vibrations to stimulate the body, improve posture, increase range of motion, promote muscle strength, and reduce physical limitations. During the Russian space program, experts found that astronauts experienced bone loss and fractures at a much younger age than people who hadn’t gone to space. Doctors in the program began using vibration therapy to strengthen astronauts’ bones and muscles.

Vibration [stimulates](https://journals.lww.com/md-journal/FullText/2019/02150/Effect_of_segmental_muscle_vibration_on_upper.31.aspx) endings in the muscle spindles, that are tiny sensor-like receptors on the muscles letting the brain know to stretch and contract. With this information, the brain calculates the muscle position and movement to control how to relax, move, stand, or adjust positions. Certain health conditions and physical injuries affect the function of the muscle spindles. Some research indicates that vibration therapy could help to rehabilitate them, relieving symptoms like reduced range of motion and mobility, muscular weakness, and pain and promotes the body’s natural production of osteoblast cells, that form new bone tissue.Vibration therapy may be applied in two ways: whole-body vibration or local vibration.

In whole-body vibration therapy, the patient stands, sits, or lie on a vibrating circular platform that vibrates at various speeds. Local vibration therapy involves a therapist placing a hand-held vibrating device applying light pressure directly on the targeted parts of the body. The direction, frequency, and intensity of vibrations affect outcomes. Some vibration machines produce only vertical vibrations, while others produce vibrations that go up and down, front and back, and sideways.

**What are the health benefits of vibration therapy?**

Research suggests that different forms of vibration therapy offer some benefits for specific conditions, particularly in cases of pain relief and muscle rehabilitation . Controlled trials and reviews reported that

* vibration therapy was effective at reducing activity-related pain and improving function in cervical disc herniation
* whole-body vibration therapy have positive effects on the [metabolic syndrome](https://www.healthline.com/health/metabolic-syndrome#1)  condition. Researchers found that the therapy helped with pain relief, mobility and range of motion, sleep quality, body composition (reduced fat), and cardiovascular markers (blood pressure and heart rate).
* Both whole-body and local vibration therapy improve gait, balance, reduced flexibility, spasticity, and mobility in people who had a stroke.
* 20-minute sessions of whole-body vibration therapy, 5 times a week for 2 weeks, significantly improved the balance and gait of subacute stroke patients
* Whole-body and local vibration therapy significantly improved muscle strength and performance in older adults with [sarcopenia](https://www.healthline.com/health/sarcopenia) — an age-related loss of muscle mass.
* A [2020 systematic review and meta-analysis](https://www.tandfonline.com/doi/abs/10.1080/09638288.2019.1688871) indicated that whole-body vibration therapy aids in reducing fat mass in adults with overweight and obesity, especially when combined with traditional weight loss strategies like diet and exercise.
* whole-body vibration exercise reduced pain associated with musculoskeletal conditions like osteoarthritis, fibromyalgia, and chronic low back pain.
* Adults with nerve damage (neuropathy) due to chemotherapy reported that whole-body vibration therapy was effective at reducing pain and had no adverse effects.
* Adult males with mild stress urinary incontinence after prostate cancer surgery indicated that whole-body vibration therapy for 4 weeks was effective at reducing symptoms.
* Local vibration therapy can improve muscle strength, with or without accompanying training programs in healthy adults .

**What are the risks of vibration therapy?**

Clinical observations have suggested that this therapy should not be used, or used with caution in the [following cases](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9528696/) :

* stress fractures
* nerve damage
* conditions that cause seizures
* after joint replacement
* recent surgeries
* pacemakers
* areas with open or active wounds and injuries
* high blood pressure
* clotting disorders (or high risk of clotting)
* pregnancy

Vibration therapy involves applying different speeds and frequencies of vibration to the body to activate a nervous and muscular response. Vibration therapy (VT) has been proposed as an option to improve physical performance and reduce the negative effects of ageing on bone, muscles and tendons. VT provides anabolic mechanical signals to bone and musculo-tendinous system. The best effects seem to be achieved with devices that deliver low-intensity stimuli at high frequencies providing linear horizontal displacement.

Aging is responsible for bone density decrease, loss of skeletal strength and muscle dysfunction, that have severe impact on quality of life and social costs. It has been proven that bone and muscle tissues are influenced and respond to local dynamic loading. This effect can be used to compensate the atrophy induced by disuse and aging or to improve bone and muscular function.

The human body is daily exposed to relatively few low-frequency (1–3Hz), large-magnitude (2000–3000 microstrain) events but is subject to several high-frequency (10–50 Hz), low-magnitude signals (postural muscle contractions). Vibration therapy (VT) consisting of low-magnitude high-intensity (LIV) stimuli represents a good way to safely deliver relevant mechanical signals to patients who cannot exercise to build musculoskeletal strength.

Two wide categories of vibrating devices are actually available on the market: the so-called whole-body vibration (WBV) devices and vibration devices locally applied on a single muscle. Both are based on a mechanical stimulation characterized by frequency (in Hz) and amplitude of the oscillation induced (peak to peak displacement in mm) but they widely differ in terms of clinical applications. WBV applications have a vibration frequency in the range 20–50 Hz whereas local application to specific muscular district tolerates a much higher frequency range (around 300–500 Hz). Since the vibration can be applied with a wide spectrum of frequencies and settings[https://pmc.ncbi.nlm.nih.gov/articles/PMC4915454/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4915454/#b5-147-156), different effects on healthy and pathologic tissues are possible. Most common applications are: pain contro, improvement of muscle force and flexibility, reduction of fatigue onset and accelerate rehabilitation and increase bone density[https://pmc.ncbi.nlm.nih.gov/articles/PMC4915454/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4915454/#b12-147-156).

Vibration therapy provides anabolic mechanical signals to bone and musculo-tendinous system, which mimic motion and exercise influencing positively the muscle function and coordination. The influence on bone metabolism is achieved through mechanical regulation of mesenchymal stem cells, which provide progenitors for bone growth. Vibration can alter stretch reflex sensitivity and in turn affect the motor unit threshold, firing rate and maximal voluntary strength on muscle action. The effect of vibration depends on the duration and frequency of the stimulus provided. If applied briefly (2 – 25 seconds) vibration resulted in additional excitation of the motor neuron pool which increased initial firing rates and ultimately enhanced force production. If applied for prolonged periods (30+ seconds), a decrease in maximal voluntary strength occurs via presynaptic autogenic inhibition.[https://pmc.ncbi.nlm.nih.gov/articles/PMC9528696/](https://pmc.ncbi.nlm.nih.gov/articles/PMC9528696/#ref-134479) Presynaptic autogenic inhibition is a reduction of muscle spindle activity and golgi tendon organ activation characterized by lower group discharge rates, decreased reflex magnitude and increased (slow) reflex latency, that reduces the net excitation of the motor neuron pool and decreases maximal voluntary strength.

Vibration therapy may be indicated for myofascial pain, autogenic muscle inhibition and delayed onset muscle soreness. While there are no direct contraindications for its use clinicians should proceed with caution for the treatment of certain conditions, such as stress fractures / reactions, neuropathy, fibromyalgia epilepsy, pregnancy, recent surgery or joint replacement, metal pins or plates, pacemakers, areas with skin rash or open wounds and in individuals with hypertension or those at risk for clotting.

Clinical Application

While there are many proposed benefits of vibration therapy the literature most strongly supports its clinical application for pain relief, improving tissue extensibility, increasing strength, and decreasing muscle soreness, since the ability to regulate muscle activity up or down via vibration has been demonstrated to be beneficial for clinical use. The recommendation for application is to provide gentle pressure with continuous motion into the affected tissue.



Figure24. . Hyperice Venom Shoulder unit providing pulsed or continuous vibration in conjunction with superficial heat to reduce pain and improve tissue mobility. (203-205)

**Acoustic resonance therapy (ART)**

Acoustic resonance therapy (ART) is a novel vibrational treatment that delivers patient-specific resonant frequency acoustic energy. In a pilot study, ART was effective for the acute treatment of nasal congestion. Clinical studies have demonstrated that acoustic energy or vibration applied to the sinonasal cavities results in quantifiable nasal decongestion and present an underexplored non-pharmacologic treatment option for nasal congestion.[https://onlinelibrary.wiley.com/doi/10.1002/alr.23284](https://onlinelibrary.wiley.com/doi/10.1002/alr.23284#alr23284-bib-0004)

Acoustic resonance therapy (ART) is a novel method of delivering acoustic energy to the nasal cavity and paranasal sinuses. ART is differentiated from non-resonant acoustic vibrational therapies because ART delivers vibrations at the specific resonant frequency of the sinonasal cavities to achieve maximum transfer of energy. Because the resonant frequency is directly dependent on the volume of the airspaces being vibrated (as with a musical instrument) based on the Helmholz equation, the calculation of nasal cavity and paranasal sinus volumes is critical to “tuning” the vibration to the optimal resonant frequency, which, like all aspects of anatomy, is variable and patient specific. Resonant frequency vibration energy has been shown to improve delivery of nebulized topical medications and, reduce nasal congestion when applied externally to the face.

ART demonstrated benefits of vibrational energy for the treatment of upper and lower airway disease. Specific breathing exercises that incorporate humming have been practiced for centuries and have been shown to reduce symptoms of chronic rhinosinusitis including nasal congestion. Vibration systems have been used extensively in respiratory therapy for patients with chronic lower respiratory disorders. Vibration is thought to decrease congestion through three possible mechanisms:

(1) sinonasal mucosal vasoconstriction,

(2) increased muco-ciliary clearance, and

(3) decreased mucus viscosity.

 Vibration has also been shown to result in vasoconstriction in vivo.[https://onlinelibrary.wiley.com/doi/10.1002/alr.23284](https://onlinelibrary.wiley.com/doi/10.1002/alr.23284#alr23284-bib-0018) Furthermore, in patients with chronic pulmonary disease, techniques using vibration have been shown to increase muco-ciliary clearance by aiding in mucus expectoration, decreasing airway collapsibility, and facilitating airflow. In the upper airway, other forms of vibrational therapy for the treatment of nasal congestion have demonstrated similar effects. A single-frequency vibrational device with positive pressure increased peak inspiratory nasal airflow and improved nasal-related quality of life in patients without fixed anatomic obstruction who suffer from nasal congestion. However, current treatment options lack the delivery of vibrations at sinonasal resonant frequencies, which are matched to individual patient anatomy.

Delivery of energy at the correct resonant frequency and intensity has been demonstrated to be important in optimizing drug deposition in nebulization of topical sinonasal medications.[https://onlinelibrary.wiley.com/doi/10.1002/alr.23284](https://onlinelibrary.wiley.com/doi/10.1002/alr.23284#alr23284-bib-0008)Acoustic resonance happens when sound waves cause an object or system to vibrate at its natural frequency. This natural frequency of vibration denotes the maximal energy transfer in and out of the object.  
Every object or space has its own natural frequency, which is the rate at which it vibrates. When sound waves with the same frequency as an object’s natural frequency hit the object, the vibrations grow stronger, creating resonance. One way to restore balance and harmony within the body is through vibrational resonance therapy (VRT). Resonance therapy uses vibrations to encourage the body to heal itself and return to a state of optimal health. Resonance therapy, also called sound resonance therapy or vibrational resonance therapy (VRT), is a form of sound healing or sound bath that utilises sound waves to restore balance and harmony within the body.

Sound healing therapy can be used to treat a variety of physical and emotional problems, and is thought to work by affecting the meridians and energy pathways within the body. VRT is best explained as a combination of sound therapy, music therapy, and whole-body vibration therapy. The benefits of vibrational sound therapy are numerous. Vibrational sound therapy can:

* Reduce stress
* Reduce pain
* Ease blockages and tension
* Reduce depression
* Improve sleep quality and mood
* Boost creativity
* Improve concentration
* Balance energy fields (aura) and chakras
* Lower blood pressure
* Support muscle recovery
* Relax

Resonance therapy, also called sound resonance therapy or vibrational resonance therapy (VRT), is a form of sound healing or sound bath that utilises sound waves to restore balance and harmony within the body. VRT is an overall safe and effective way to improve whole-body health, and it can be used individually or as a complementary. The human body is an amazing machine, capable of incredible feats. Sometimes it can fall out of balance, leading to pain and ill health. One way to restore balance and harmony within the body is through vibrational resonance therapy (VRT). Resonance therapy uses vibrations to encourage the body to heal itself and return to a state of optimal health.

Sound healing therapy can be used to treat a variety of physical and emotional problems, and is thought to work by affecting the meridians and energy pathways within the body. It is primarily used by a trained practitioner to affect the autonomic nervous system for personal growth.VRT is best explained as a combination of sound therapy, music therapy, and whole-body vibration therapy - all of which are very similar, yet slightly different. The difference between the two is that music therapy uses a cacophony of frequencies and harmonies that trigger an emotional response, and is primarily used to treat a variety of mental disorders. Sound healing, on the other hand, is the use of sound waves - such as the solfeggio frequencies - using a variety of tools, such as Tibetan singing bowls, vocal toning and binaural beats, to restore well-being within the body. Whole-body vibration is when the entire body is exposed to vibrations. These vibrations cause a release of endorphins to improve mood, reduce stress, and promote relaxation. It is also used with the elderly to promote tendon, ligament and muscle strength, as well as bone density.

What is Vibrational Resonance Therapy?

Vibrational resonance therapy incorporates the three principles of healing all at once.It is the application of frequencies to be felt as vibrations, which create resonance with the human cells, for deeper relaxation, muscle stimulation and further control over the autonomic nervous system.

These frequencies and harmonies interact with the energy pathways of the body for vibrational resonance to occur. Sound healing is a real and effective way to heal the body, mind, and soul.

History of Sound Therapy

The history of sound therapy can be traced back to ancient cultures such as the Chinese, Indian, and Ancient Egyptians. These cultures believed that different sounds could affect different areas of the body and that listening to or singing specific sounds, could improve the health and find spiritual order. For example, the Chinese believed that different sounds can release energetic blockages to release tension. Indian culture believed that sound was a gateway to the spiritual world and to connect with the divine. And in Ancient Egyptian, it was believed that music was an essential part of the afterlife journey.

Sound healing works because the cells constantly vibrate at different frequencies, and these frequencies trigger different cellular functions. Sound vibrations cause a resonance with the molecular biology to harmonise it into a state of self-healing. This energy is thought to manipulate the brain waves, releasing stuck energy, and shifting the mental state. By exposure to certain sound frequencies, it is possible to bring the energy fields back into balance and thus improve the health.

Is Sound Healing Good?

Sound healing is said to reduce stress, improve sleep quality, [ease anxiety and depression symptoms](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7213780/), reduce pain, and even boost the immune system. Sound therapy or sound baths involves sitting or lying down in a room while different types of sounds, including Tibetan singing bowls, crystal bowls, tuning forks, gongs, and vocal toning are played. The purpose of a sound healing session is to create sonic vibrations that help restore emotional balance. A professional sound healer uses use a variety of tools to create audible or inaudible vibrations. While many people associate sound healing with singing bowls, there are a wide variety of tools that practitioners use to facilitate healing.

Sound Healing Tuning Forks

Tuning forks are used in sound healing for their ability to produce pure tones. When these tones are emitted into the body, they can help to reduce pain and inflammation and promote relaxation. Tuning forks are typically made of metal and can be activated by striking them with a mallet or simply by clanging them together.

Since the interaction of vibrations between two objects with similar frequencies, the resonance may be termed as "sympathetic resonance." This harmonic alignment, akin to a musical harmony, is deeply healing. Resonance occurs when like frequencies find unison, creating a balanced, peaceful, and joyous state. Tuning forks exemplify sympathetic resonance. When one fork vibrates, another of the same pitch responds and extends to whole body, considered manifestations of sacred sound patterns. The vibrations from tuning forks align the thoughts and physical bodies, inducing movement and adjustment to the sound's proportions.

Sound Healing Singing Bowls

Singing bowls are another popular tool in sound healing. These bowls are traditionally made of quartz crystal, but they can also be made of other materials like ceramic or metal. Singing bowls produce a rich, full sound when they are struck with a mallet or rubbed with a dampened hand around the rim.

Sound Healing Gongs

Gongs are musical instruments that have been used for centuries in religious and spiritual ceremonies. Gongs produce a deep, resonant sound that can be both calming and energising. When gongs are played, they create vibrations that travel through the body and can help to release blocked energy. Tools that emit low frequencies are said to release emotions that are trapped in the body, because low frequencies have a vibrational quality that is similar to the frequency of emotions.

There is a wide range of sound frequencies, some of the most commonly cited frequencies include:

* Delta Waves ([0.5-4 Hz](https://en.wikipedia.org/wiki/Delta_wave)): These low-frequency waves are associated with deep sleep and relaxation
* Theta Waves ([4-8 Hz](https://en.wikipedia.org/wiki/Theta_wave)): These waves are also linked with sleep and relaxation, as well as increased creativity and intuition
* Alpha Waves ([8-12 Hz](https://en.wikipedia.org/wiki/Alpha_wave)): These waves promote calmness and focus while also reducing anxiety and stress levels
* Beta Waves ([12-38 Hz](https://en.wikipedia.org/wiki/Beta_wave)): These higher-frequency waves are linked with increased alertness and concentration

Every cell in the body has its natural frequency, known as a resonant frequency. When the cells are exposed to sound waves with a frequency that matches their resonant frequency, these waves cause the cells to vibrate. This vibration can then have a variety of effects on the body, depending on the specific frequency involved. Vibrational sound therapy, that uses therapeutic singing bowls placed on the body to create a combination of tones and vibrations that produce a state of tranquility and act as a massage for the nervous system to retune the body, mind and spirit, encourage relaxation, healing and wellness and restore the cells' natural resonance frequency.

**How it Works**

When relaxing through soothing sound and vibration, the body is affected on a cellular level, opening energy flow to move you back toward healthy alignment. Stress creates an unhealthy flow of energy, first appearing as low energy in the aura, and, later, as ill health, mentally and physically. Placing the therapeutic singing bowls directly on the body and creating a therapeutic sound wave vibration that creates physical vibration throughout whole body. As the bowls focus on the physical connection, the practitioner focuses on energetic connections. Resonance is a fundamental concept in sound therapy, impacting both the physical and energetic bodies. Innate natüre acting as resonators, the entire body responds to sound, whether consciously heard or not and vibrates, and each beat of the heart induces vibrations throughout, influencing overall health and energetic equilibrium.

Everything, in the universe, including the human body vibrates in a state of flow at a healthy resonant frequency. When disease disrupts this harmony, sound therapy reintroduces the correct frequency to restore balance and promote healing. The resonance to the human body is like a finely-tuned musical instrument. Sound waves enter the body, inducing sympathetic vibrations in living cells and promoting healthy organization. This process is akin to a deep massage at the atomic and molecular level.The human voice serves as an indicator of overall health, establishing a connection with the vibrational network of the cosmos. Crystal Bowls, through their resonant frequencies, can be seen as external sound sources that resonate with the frequencies within the body, promoting harmony and well-being. The transformative power of sonic instruments has demonstrated the ability of sound to shape, break, rearrange molecules, and even levitate objects.

Sound therapy, in which auditory and vibratory inputs are used to influence a person's physiological and/or psychological state, includes sound healing, vibroacoustic sound therapy, music, and music therapy. Practitioners of sound healing may use chimes, chanting, or drumming to create particular sound frequencies at specific intervals in an effort to promote health and healing of the mind and body. Vibroacoustic sound therapy is a sound technology that uses audible sound vibrations to decrease stress, promote relaxation, and improve health. Sound frequencies within the range of human hearing are directed to the body through a system of transducers imbedded in soft furniture. Proponents of this approach suggest that the primary outcome of vibroacoustic therapy is initiation of a relaxation response. Researchers have found that listening to certain types of music can lower blood pressure and heart rate, reduce pain, decrease anxiety  and improve sleep. Acoustic therapy could lead to cause changes in the tinnitus perception and has been appreciated by the affected people for years. The intention is to mask tinnitus, suppress tinnitus, or interrupt the tinnitus generating neural activity.

**What role does sound healing play in modern medicine?**

There's an abundance of research supporting the healing properties of sound, including ultrasound, infrared, and consciousness altering audible sound. Therapeutic ultrasound, in particular, is widely popular as a medical treatment for a variety of ailments, such as kidney stones, tumors, cancer, teeth cleaning, bone regeneration, liposuction, killing bacteria, & much more.  Sound Bath is a therapeutic mind-body practice in which the patient or participant reclines in a comfortable position, often using yoga props to align the body as they “bathe” in the sounds produced by instruments.

**How is Sound Resonance Therapy practiced?**

The practitioner utilizes a wooden mallet to produce sound from hammered metal bowls called singing bowls, by striking or inviting the bowl and by rubbing around the outside rim of the bowls. Bowls produce vibrations at different frequencies depending on the size of the bowl. Gongs, chimes, and cymbals may also be used to produce soothing vibrational sounds that gently fade out. Each singing bowl is unique with complex harmonies. The practitioner may play the bowls and other instruments in a stationary position, by walking around with the instrument, or by placing the bowl on an individual’s body. Resonance between two objects causes the second object to vibrate along with the first.  When producing sound from a singing bowl, the vibration of the bowl will cause the room to become resonant, as well.  Sound and movement become the focus and the solid and material fade into the background.  Everyone participates.  The practitioner only facilitates.

**What is the background of Sound Resonance Therapy?**

Masuro Emoto demonstrated through his frozen-water crystal photography that music, words and sound could have an effect on the shape of frozen water crystals. A singing bowl will activate the water within a person’s body as it resonates. This resonance helps to settle different body systems, by bringing breath, qi 氣, entraining with the heart and balancing the autonomic nervous system. The Sound Resonance Therapy invites the body into a relaxed, parasympathetic state, also known as the “rest-and-digest” state. Individuals often feel profound changes such as their pulses balancing out, diminished stress, increased clarity and relaxation and a higher connection with their body.  The sound seeks out blockages in our bodies and prompts the body to release into the new frequency. Varying the frequency of the sounds produced can alter brain wave states resulting in participants experiencing a high functioning state, increased creativity, and improved sleep reaching the deepest levels of the source of being.  (206-207)

**interbrain synchronization patterns**

Electroencephalographic hyperscanning used to investigate interbrain synchronization patterns in dyads of participants interacting through speech show that brain oscillations are synchronized between listener and speaker during oral narratives. This interpersonal synchronization is mediated by a lower-level sensory mechanism of speech-to-brain synchronization, but also by the interactive process that involves an exchange of information between two or more people in order to convey and receive intended meanings with speech production and perception, which are the two constitutive parts of the process. The existence of brain-to-brain entrainment which is not merely an epiphenomenon of auditory processing, during listening to one speaker, has been demonstrated.

To be effective, communication requires the ability to deliver a verbal message and the capacity to comprehend the message. Speech perception, called brain entrainment to speech, is achieved by coupling between the ongoing rhythmic neural activity of the listener and the quasi-rhythms of the speech signal and takes place during speech production, as the neural activity of a speaker correlates with the amplitude envelope of the sound of their own utterance and supports native speech intelligibility. There is a tight relationship between the neural oscillatory activity of the listener and the physical properties of the perceived message, but also between the neural activity of the speaker and the verbal output being produced.

Understanding the verbal production of others involves some form of neural coupling not only with the input signal, but also with the speaker’s neural system, and that electroencephalographic (EEG) inter-brain synchronizations are tightly linked to speech synchronizations between interlocutors. Studies have also shown that increased EEG interbrain synchronization associated with effective social coordination, is highly relevant because verbal communication is a cooperative process that requires individuals to actively coordinate their thoughts in a dynamic and adaptive way. Brain oscillatory activity does not only entrain to speech, but also becomes synchronized between the listener and the speaker due to (*i*) the shared sensory stimulus (speech signal), and (*ii*) the verbal communication itself (social interaction). Due to the existence of brain-to-brain entrainment to speech during communicative verbal interaction, the neural oscillators from two autonomous human brains interact (expressed via synchronization), while perceiving and producing oral narratives individuals engage in a verbal exchange. Speech, which is a shared sensory stimulus, explains the existence of an interbrain coupling process mediated by the Listener’s and/or the Speaker’s brain-to-speech entrainment

The oral narrative, concomitant with the inter-brain coupling of neural oscillations, is termed ‘brain-to-brain entrainment’ and showed enhanced synchronization between the EEG oscillatory activity of listeners and speakers in delta, theta, alpha and beta frequency bands. The brain synchronization in delta and theta bands is mediated by the speech signal, since entrainment occur between the neural systems of the senders and the receivers, but also between their brains and the shared message, through entrainment to the audio envelope. The synchronization pattern found in the alpha and beta band emerging directly from the mutual interaction of the dyad, emphasize the social essence of verbal communication without being mediated by the physical properties of speech (i.e., a “pure” instance of brain-to-brain entrainment). The vast majority of studies, which are focused on the relationship between a listener’s neural oscillatory activity and the properties of the perceived speech signal, have provided ample evidence that neural entrainment to speech occurs in the low-frequencies and found that cortical entrainment to the speech envelopes mainly in the delta and theta bands. The neural oscillators of speakers align with the verbal signal that is produced even including alpha band, which has a role in speech processin.

Language production and comprehension are tightly interwoven as coherent phenomenon, depending to a great extent on similar neural mechanisms in line with the idea of corollary discharge, which is a specific instance of an efference copy that allows monitoring and controlling of the interference of one’s own production during ongoing verbal production. The finding of significant entrainment of speakers to their own speech responds to a form of corollary discharge that permeates the neural system during vocalization.In addition to concomitant brain entrainment to speech in the delta and theta band, markers of interbrain synchronization were found at these frequency bands. This novel brain-to-brain entrainment effect are fully mediated by the speech signal, given that both the speaker and the listener’s neural slow-oscillators also synchronize with the speech signal.

While delta-like fluctuation rates correspond to the largest linguistic structures, such as sentences and phrases, whose temporal dynamics tend to map onto these frequency ranges, theta frequencies, correspond to the rate at which syllables regularly occur in a continuous speech stream. The interbrain synchronization pattern observed in the slow neural oscillations can be considered a transitive property of a series of brain-to-speech synchronization mechanisms, shared by speakers and listeners, which underlie the encoding of long time-scaled information streams.

Oscillatory activity in alpha frequencies has been typically associated with attention-mediated processing, and the role of attention in successful verbal communication is undeniable. Attentional resources need to be coordinated among interlocutors not only to understand each other, but also to anticipate forthcoming speech, and to segment the continuous speech signal into meaningful units. On the other hand, oscillatory modulations in beta frequencies are supposed to reflect the close relationship between language comprehension and motor functions. It has been shown that the beta rhythm modulation by speech sounds elicits a pattern in the somatosensory cortices of the listener that resembles the activity that subtends actual speech production in the speaker[https://www.nature.com/articles/s41598-017-04464-4](https://www.nature.com/articles/s41598-017-04464-4#ref-CR37). Oscillations in the beta (and theta) band are instrumental in predicting the occurrence of auditory targets. Alpha and beta constitute distinct rhythmic classes that are both involved in top-down processing. Brain-to-brain entrainment in the alpha-beta frequencies can be conceived as part of an emergent property of coupled systems that are mutually dependent due to interactive prediction processes[https://www.nature.com/articles/s41598-017-04464-4](https://www.nature.com/articles/s41598-017-04464-4#ref-CR40). The increased oscillatory brain activity in the sensorimotor mu rhythm and its alpha-band component, are associated with effective social coordination.

The finding that brain-to-brain entrainment during oral narrative emerges from on-line mutual interaction is in good agreement with theoretical accounts postulating that brains work differently in social interactive situations than in isolation. Verbal communication should be seen differently from the mere sum of production and perception, and communicative interactions should be conceived as autonomous processes influenced by both the participants and the situation[https://www.nature.com/articles/s41598-017-04464-4](https://www.nature.com/articles/s41598-017-04464-4#ref-CR44). Brain-to-brain coupling also modulates neural activity (and behavior) over and above brain-to-speech coupling, resulting in patterns that do not emerge in isolation[https://www.nature.com/articles/s41598-017-04464-4](https://www.nature.com/articles/s41598-017-04464-4#ref-CR48).The interbrain synchronization patterns between listeners and speakers support the existence of brain-to-brain entrainment during an exchange of oral narrative.

With the continued development of neurofeedback technologies and a better understanding of the brain, a variety of methods of brainwave entrainment and consciousness including deeper meditation and relaxation, cognitive enhancement, pain reduction, and alleviation of conditions such as anxiety and depression are used in various settings to achieve different results. Brainwave entrainment involves introducing a stimulus with a frequency that matches the desired brain waves, with the goal of synchronising the two. For example, playing audio with a frequency of 8 Hz enters a low alpha state, to relax.

1. **Monaural Beats**

are a type of auditory brainwave entarinment that involves presenting a single tone that has been modified to create the beating pattern. Monaural beats reduce anxiety and promote relaxation. Tuning a guitar, for example, it’s common to use a note on one string to get another in tune with it, but when they’re still slightly out of sync, a pulsing sound that’s the remaining difference between them is heard.

1. **Binaural Beats**

Heinrich Wilhelm Dove discoverd binaural beats in 1839 when he used tubes to route the sounds of two slightly different tuning forks to each ear, with the listener observing the appearance of a third tone. Playing two different frequencies into opposite ears creates the perception of a beating pattern whose frequency is the difference between those two present tones. For example, playing a 400 Hz signal into one ear and a 410 Hz signal into the other, a 10 Hz beat would be heard. The  third tone isn’t present in the signals themselves but is generated in the superior olivary nucleus, a structure deep in the brainstem, making it something of an illusion. Binaural beats can reduce anxiety and improve quality of life, as well as provide pain relief.<https://link.springer.com/article/10.1007/s00426-018-1066-8>

1. **Isochronic Tones**

Making a catergory of brainwave entrainment called auditory beat stimualation, is a single audio signal of a series of tones presented at regular intervals, which creates the pulsing sound. It is a single tone repeating at the desired brainwave frequency.

1. **Photic Stimulation**

involves a strobe light flickering at the desired brain wave frequency and the resulting entrainment is known as the ‘photic driving response’ . Photic stimulation is used to diagnose conditions like epilepsy, which is an abnormal pattern of brain activity that can start in response to flickering light patterns. Researchers found that patterns of light could produce hallucinatory experiences and altered states of consciousness.<https://journals.sagepub.com/doi/abs/10.2190/5K21-DDWL-E66B-2CXE?journalCode=icaa> Photic stimulation requires  a more difficult set-up than the other auditory options; finding strobe lights or flickering LEDs are needed and should be tuned to the desired frequency, otherwise the resulting effects will be of a quite different variety.

1. **Audio-Visual Entrainment**

a form of brainwave entrainment that combines both auditory and visual stimuli to produce changes in brainwave activity. Combining auditory and visual signals, enhances the brain’s entrainment and produces deeper, more immersive states of relaxation and concentration. A device or devices capable of synchronizing flashing lights and pulsing sounds at specific frequencies that correspond to desired brainwave states are needed. Research has shown from relaxation to improved cognition and reduction in symptoms of pain and depression.

1. **Haptic Stimuli (tactile stimulation)**

Haptics relate to touch and tactile stimuli using vibrations of different frequencies that are picked up through the skin to influence brain rhytms. The vibrations can be achieved with physical touch, such as using a massage gun, but can also occur through low-frequency audio tones. Haptic stimulation improves short term memory. In the 1980s, researcher Paul Bach-y-Rita coined ‘sensory substitution,’ the idea that one sense can be turned into another. He then developed a device that vibrates the tongue in response to visual input. Neuroscientist David Eaglement built the neurosensory, a wristband that vibrates in response to sounds, allowing the deaf to hear through touch. The brain is great at deciphering patterns, capable of making sense in time any given data.

1. **Transcranial Magnetic Stimulation (TMS)**

The brain relies heavily on electric signals to communicate, that can be changed by applying a magnetic force. A magnetic coil with an electric pulse is placed over the head to create a current and stimulate nerve cells within the brain. It has been shown that TMS can entrain alpha brain waves to treat mental illnesses from depression to dementia and stroke rehabilitation. As well as enhancing cognitive functions and boosting memory. TMS is technically a noninvasive method of altering brain rhythms

1. **Neurofeedback Meditation**

A quite different form of brainwave entrainment, as the external stimulus is the digital readout of the brain waves themselves. An EEG headset that records the brainwave activity during meditation, gives constant feedback and lets the participant noticing how the brainwaves change, and makes neurofeedback training more powerful so that the mind can adjust the brain waves accurately and easier for better control over the mind.. This method relies on the internasl state of the person rather than the frequrency of the external device eventhough there is no reinforcing sound or visual to give a push. (208-210)

**Compassion-focused therapy (CFT)**

Compassion-focused therapy (CFT) aims to promote mental and emotional healing by encouraging people in treatment to be compassionate toward themselves and other people. [Compassion](https://www.goodtherapy.org/blog/psychpedia/definition-of-compassion), both toward the self and toward others, is an emotional response as an essential aspect of well-being for improved mental and emotional health.  the CFT approach incorporates theories, principles, and techniques from various schools of psychology, treatment modalities, and religion.Some main components of the approach are aspects of:

* [Cognitive behavioral therapy](https://www.goodtherapy.org/learn-about-therapy/types/cognitive-behavioral-therapy)
* Developmental psychology

[Evolutionary psychology](https://www.goodtherapy.org/blog/psychpedia/evolutionary-psychology)

* [Social psychology](https://www.goodtherapy.org/blog/psychpedia/social-psychology)
* Neuroscience
* Buddhist philosophy.

CFT is grounded in current understanding of basic [emotion](https://www.goodtherapy.org/blog/psychpedia/emotion) regulation systems: the threat and self-protection, the drive and excitement, and the contentment and social safeness systems. Treatment sessions highlight the association between these systems and human thought and [behavior](https://www.goodtherapy.org/blog/psychpedia/behavior). The aim of CFT is to bring these three affect systems into balance.

How Does CFT Work?

According to CFT theory, the threat, drive, and contentment systems evolved throughout human history in order to facilitate survival. Early humans were eager to avoid or overcome threats, seek resources such as food or intimacy, and enjoy the benefits of being part of a social community.

Proponents of CFT suggest that these systems are still active and affect human emotions, actions, and beliefs. If a threatening stimulus is received, for example, a person may experience different feelings (such as [fear](https://www.goodtherapy.org/learn-about-therapy/issues/fear), [anxiety](https://www.goodtherapy.org/learn-about-therapy/issues/fear), or [anger](https://www.goodtherapy.org/learn-about-therapy/issues/fear)), exhibit various behaviors (submission or a [fight or flight](https://www.goodtherapy.org/blog/psychpedia/fight-or-flight) response), and develop certain cognitive biases (jumping to conclusions, [stereotyping](https://www.goodtherapy.org/blog/psychpedia/stereotype), or assuming it is always better to be safe than sorry).

The drive system endeavors to direct individuals toward important goals and resources while fostering feelings of anticipation and pleasure. People with an over-stimulated drive system may engage in risky behaviors such as unsafe sexual practices or [drug and alcohol abuse](https://www.goodtherapy.org/learn-about-therapy/issues/drug-and-substance-abuse).The contentment system is linked with feelings of [happiness](https://www.goodtherapy.org/blog/psychpedia/happiness), which are not associated with pleasure seeking, nor an absence of threats. Rather, the state of positive calm is tied to an awareness of being socially connected, cared for, and safe. This soothing system acts as a regulator for both the threat and drive systems. (211)

**ACCESS BAR THERAPY**

There are 32 points (bars) on the head that represent different areas of life such as communication, awareness, money, control, and creativity. During an Access Bars session, a clinician gently touches these points to release the limiting thoughts, feelings, beliefs, and emotions that correspond to the specific bar being activated. By touching the areas where the junk files that have been stored for ages, such as negative beliefs, unhelpful thoughts, feelings and emotions, since childhood or a new virus that popped up out of nowhere, like financial stress caused by an unexpected layoff, theyare released like re-booting a computer!

***What are the benefits of Access Bars?***

**1. Reduced Stress:** Each session can help lower stress levels and promote a sense of calmness, relaxation and tranquility.

**2. Clearer Mind:** Most people leave the session feeling like they have a clearer and more focused mind.

**3. Improved Sleep:** Bars can improve sleep quality through increased relaxation.

**4. Emotional Release:** Releasing blocked energy from specific points can relieve suppressed emotions, helping individuals process and heal.

**5. Enhanced Creativity:** Clearing energetic blockages around creativity may lead to a surge in innovative thinking and artistic expression.

The main results showed that the practice of Access Bars to Consciousness releases conditions and schedules that cause beliefs, limitations and discomfort and promotes a feeling of lightness, peace and inner harmony; deep relaxation and pain relief in the body; slows down the mind; decreased anxiety, stress and compulsion; increase in mental clarity, self-confidence and self-esteem; improves the way of dealing with problems and everyday situations, bringing more awareness of the situation; helps to release memories of trauma and conditioning created since childhood; improves sleep pattern, fights anxiety, depression, stress, migraine, panic attacks, abuse and health problems.

Access Bars is an energy healing technique that involves gently touching 32 specific points on the head and releasing any intrusive thoughts that live in that area. The practice is based on the concept that these points store electromagnetic charges associated with thoughts, feelings, and emotions and correspond to different aspects of an individual's life, including areas such as money, relationships, communication, creativity, and more. For instance, the point corresponding to "money" is believed to help release limiting beliefs and patterns related to financial abundance. The "communication" point might aid in improving how one communicates with others, while the "joy and sadness" point could help release stored emotions or negative thoughts.

Each Bars session lasts about 60-90 minutes, depending on how fast the mind clears itself. During the session, applying very light pressure to 32 points on the head that are connected with various aspects of life and holding those points clears the thoughts that are holding back, whether the person know it or not. After each session, people report different effects, ranging from feeling like they just had a nice massage to having a life-changing session. It is a completely individual experience.

## [GT A Psychologists](https://cbtpsychology.com/psychologists-in-gta/)

## Fig. 25. Access Bar Therapy.

## Some **common reactions** after an Access Bars session:

**1. Deep Relaxation & Mental Clarity**

 Many people feel **light, peaceful, and clear-headed** right after the session.  
The mind feels **less cluttered**, making it easier to focus and be present.  
Some report feeling as if they just had **a deep meditation or a full night’s sleep**.

**2. Emotional Release**

 If old emotional blockages are released during the session, people might feel:

* **Unexpected emotions surfacing** (such as sadness, joy, or relief).
* A sense of **emotional catharsis**, similar to how you feel after a deep conversation or therapy session.
* Increased **self-awareness and introspection** about past experiences.

This emotional shift is **a sign that energy is clearing**, allowing to move forward without old emotional baggage.

**3. Heightened Sensitivity or Increased Awareness**

Some people become **more aware of their thoughts, emotions, and surroundings**.  
 **shifts in relationships**—feeling drawn to certain people and distancing from others.  
 Sensitivity to **energies, emotions, or environmental stimuli** may temporarily increase.

**4. Temporary Fatigue or Tiredness**

 If deep **energetic clearing** takes place, people may feel:

* A **need to rest** as the body integrates the shifts.
* Mild fatigue or drowsiness, similar to after a **massage or deep healing session**.
* A desire to **sleep longer or take naps**, which is **perfectly normal**.

This is a sign of deep healing.

**5. Physical Detox Reactions**

Because Access Bars helps **release stored energies**, the body may detox in **subtle ways**:

* Increased **thirst** (drink more water to help flush out toxins).
* Mild **headaches or dizziness** as energy shifts.
* A temporary **change in digestion** (this usually balances quickly).

These typical responses are part of the body’s **natural recalibration** process and pass within **24–48 hours**.

There are many positive effects of Access Bars. Some include:

* Increased calm, peace, and relaxation
* Less reactivity
* Reduced limiting thoughts, beliefs, and feelings
* Reduced anxiety and depression symptom severity
* Significant reduction in stress and body tension
* Better and sound restful sleep
* Greater Mental clarity and decisiveness
* Increase in happiness and joy
* Deeper relaxation
* Relief from overwhelm and panic attacks
* Weight management
* Betterment of physical health
* Increase in Emotional Intelligence
* Relief from depression and deep-seated sadness
* Increase in energy levels through the day
* Relief from migraines and tension headaches
* Improvement in illnesses not responding to medical treatments
* Improvement in OCD, ADHD symptoms
* Anger management
* Internal motivation
* More ease with difficult areas of the life
* Removal of financial blocks
* Improvement in communication
* Enhancement of intuition and power
* Improvement in creativity Increase in productivity and efficiency

**What Are The Bars?**

* The Bars are 32 points on the head that store the electromagnetic component of thoughts, feelings, emotions, ideas, beliefs, and considerations as they are stored in the brain. When activated, The Bars begin to release the thoughts, feeling, emotions, considerations and beliefs that have been stored in any lifetime that limit . The Bars can help facilitate reduction of stress, pain and trauma throughout the body and increase positive attitudes toward life.
* When The Bars are lightly touched, the brain waves actually slow down, allowing behavioral patterns, belief systems, and points of view that have been running from childhood or from other lifetimes to be accessed. The brain wave’s change from beta waves, which are attentive mode, to alpha/theta waves, which are relaxed/fall asleep mode. Brain wave measurement shows increased brain coherence after receiving The Bars. Access Bars optimize brain performance, increase concentration ability and improve emotional stability.
* The Bars release solid decisions, that can not change, about any area of life and begin to dissolve judgment from within.
* Access Bars help with stress reduction, deep relaxation, ease of sleep, dissipating mind chatter, releasing trauma, reducing overwhelm, decreasing negative and limiting thought patterns, changing negative behavioral patterns, improving overall wellbeing, and increasing feelings of calmness, inner peace, happiness and gratitude.
* Access Bars have assisted thousands of people to change many aspects of their life and body including stress, anxiety, depression, trauma, health, weight, body image, sleep, money, sex, relationships, and so much more!
* People get their Bars run to ease stress, sleep better, relieve grief, receive more, create wealth, reverse aging, reduce anxiety, boost creativity, release trauma, optimize health, quiet their mind, increase inner peace, have more space, judge themselves less, improve body image, alleviate depression, increase productivity, enhance relationships, have more ease at work or school, have a sense of peace and calm.
* The Bars is a holistic complementary technique that activates the body’s innate ability to self-heal. Access Bars complement any conventional or alternative treatment or therapy and have been found to increase the capacity and potency of other healing modalities.

What Is An Access Bars Session?

* During an Access Bars Session 32 Bars points are lightly touched. This process begins to release the electromagnetic charge or polarity of the thoughts, feelings, emotions, ideas, beliefs, considerations and decisions as it is stored in the brain.
* During a session, the running Bars begin to release thoughts, feelings, emotions, beliefs and limiting programs that no longer serve.
* There is no need to remove any clothing, only the head, hands and feet (optional) are touched. It's nice to have a blanket on hand, as sometimes the body temperature may change.
* Due to the electrical discharge that occurs during a session which activates the synapses in the brain the body may require more salt, sugar or water after a session.
* The Bars can be run anywhere.
* Access Bars is a gentle touch hands-on process that releases hundreds of thousands of points of view which are limiting in different areas of life. These areas include body, aging, healing, sexuality, money, joy, sadness, control, awareness, creativity, plus many more.
* Having Bars run tends to be a relaxing and nurturing process from the worst feeling of having had great massage, to the best case scenario, in which whole life can change into something greater with total ease!
* Many people go to sleep – even in a very noisy environment. Some people have images come to them, others see colors, or feel sensations in their bodies such as buzzing, tingling, warmth, twitches or shivers. Mostly, there is a sense of deep relaxation.
* Everyone is different so there is no “normal” Access Bars Session. Each session will be different, every time. (212-215)

**Shakti Therapy**

The concept of Shakti is deeply rooted in Hindu philosophy, where it represents the primordial cosmic energy and the dynamic force behind all creation, maintenance, and destruction in the universe. The divine feminine counterpart to the masculine principle of Shiva Shakti’s swirling energy brings life and movement to Shiva’s stillness and consciousness. Central to Shakti Therapy is the concept of chakras – those spinning wheels of energy that run along the spine. Each chakra is associated with specific physical, emotional, and spiritual aspects of being. In Shakti Therapy, practitioners work to activate and balance these energy centers, promoting overall well-being. It’s like giving to the energetic body a tune-up, making sure all systems are running smoothly.

The key principle of Shakti Therapy is the integration of mind, and body. Unlike some approaches that focus solely on the physical or the mental, Shakti Therapy recognizes that true healing comes from addressing all aspects of the being. It’s a holistic approach that doesn’t just put a band-aid on symptoms but seeks to address the root causes of imbalance. Meditation and visualization exercises of Shakti Therapy quiet the mind and connect with the divine feminine energy. Breathwork and pranayama techniques, involving rapid breathing to stimulate energy flow and the state of the mind, that are crucial in Shakti Therapy, influence the energy.

Physical postures and movements including gentle yoga poses, free-form dance, or specific mudras (hand gestures). play a role in Shakti Therapy. The goal is to get energy flowing freely through the body, releasing blockages and promoting balance. It’s like giving to the energy body a good stretch and shake, working out all the kinks and knots. Sound healing and mantras are another powerful tool in the Shakti Therapy arsenal. The use of specific sounds and vibrations can have a profound effect on the energy and consciousness such as chanting “Om Shakti” or listening to the soothing tones of crystal singing bowls. It’s like tuning the body to the frequency of the universe, aligning with cosmic harmony. Energy work and subtle body manipulation are key components of Shakti Therapy. Practitioners may use techniques like Reiki or hands-on healing to work directly with the energy field. It’s like getting an energetic massage, releasing blockages and promoting the free flow of life force.

Benefits of Shakti Therapy

* Emotional healing and balance: Shakti Therapy can be a powerful tool for processing and releasing emotional baggage receiving an unconditional love and acceptance.
* Self-awareness and personal growth are common outcomes of Shakti Therapy. Connecting more deeply with the inner wisdom and intuition, inspires new insights into the patterns, beliefs, and behaviors. It’s like holding up a cosmic mirror.

Physical health improvements are reported by those who engage in Shakti Therapy. Balancing the energy and reducing stress have positive effects on the overall health such as improvements in chronic conditions, better sleep, and increased vitality like giving the body an energetic support. Shakti Therapy is a pathway to spiritual awakening and enlightenment. Awakening the Kundalini, by connecting with divine feminine energy, profound shifts in consciousness and a deeper sense of connection is experienced. It’s like upgrading the spiritual operating system, accessing higher levels of awareness and understanding. Scientific research on meditation, breathwork, and energy healing are providing evidence-based support for many of the techniques used in Shakti Therapy. The potential of Shakti Therapy touching on emotional and physical aspects of well-being for personal transformation is truly awe-inspiring open to profound healing, growth, and awakening by unlocking a secret door within the self and tapping into the power of divine feminine energy, accessing realms of wisdom and power.

This holistic approach offers a path to wholeness and empowerment through physical healing, emotional balance, or spiritual growth. Healing is a journey, not a destination. Shakti Therapy offers a map and tools for this journey. The life of the individual is an expression of the same laws which govern the universe. All matter is a relatively stable form of Energy. At every moment creation is going on, as rejuvenascent molecular activity, again at every moment there is also molecular death and loosening of the forms at the same time. Creation did not take place only at some past time, nor its dissolution will not be the only one in the future. At every moment of time there is both. The Power (Shakti) and the possessor of Power (Shaktiman) are one.

Creative evolution of the universe differs from the evolution in it. Cosmic evolution is in the nature of a polarization in Being toward into static and kinetic aspects. This is symbolized in the Shakta Tantras by their comparison of Shiva-Shakti to a grain of gram (Canaka). This has two seeds which are so close together to seem one, and surrounded by a single sheath. The seeds are Shiva and Shakti and the sheath is Maya. When the sheath is unpeeled, Maya Shakti operates, the two seeds come apart. The sheath unrolls when they are ready to germinate. As the universe in dissolution sinks into a lost Memory and born again from the germ recalled Memory or Shakti.

Subject and Object in Pure Being are in indistinguishable union as the Supreme Shiva-Shakti. This unity is broken up into Subject and Object. This does not take place all at once. There is an intermediate stage of transition, in which there is a Subject and Object, but both are part of the Self, which is supposed to know its Object to be Itself in reality, but in experience they are wholly separate, the Object being perceived as outside of the Self. The process and the result are the work of Shakti, whose special function is to negate her own fullness.

In the first stage, Shakti withdraws Herself and leaves standing by itself. The 'I' side (Aham) becomes the 'I-This' (Aham-Idam) experience when completed. Simultaneously she presents Herself as a 'This' (Idam); the emphasis being at first laid on the 'I' and then on the 'This'. In the second and third stage, also in the fourth which follows, there is an 'I' and a 'This' and not the indistinguishable 'I - This' of the Supreme Experience, both the 'I' and the 'This' are experienced as aspects of the Self. As a preliminary to the division which follows, the emphasis is laid equally on the 'I' and the 'This'.

At this point Maya-Shakti intervenes and completely separates the two in the form of mind and matter. One does not produce the other. Both are produced at the same time and exist as modes of the same Cause. There is a necessary parallelism between the Perceived and the Perceiver, because Mind and Matter are one at the base as modes of the same Power, acting one on the other. Mind is the subjective and Matter the objective aspect of the polarized Consciousness. The Mind is the Self. Both Mind and Matter exist in every particle of the universe. Pure Consciousness is fully involved in the densest forms of organic matter, which is not 'inert' but full of 'movement' (Spanda) while the Supreme Consciousness (Cit Shakti) does not move.

Matter in all its forms of density is present in everything. Life, which displays itself with the organization of matter, is potentially contained in the Being. Inorganic matter is a 'lifeless' form. From this deeply involved state Shakti enters into higher organized forms. Prana or vitality is a Shakti, the Mantra form of which is 'Hangsah'. With the Mantra 'Hang' the breath goes forth, with 'Sah' indrawn, a fact which anyone can verify by inspiring in order to pronounce the letter 'H'. The Rhythm of Creative Power as of breathing (a microcosmic form of it) is two-fold: an outgoing (Pravritti) or involution as universe, and an evolution or return (Nivritti) of Supreme Power to Itself.

Shakti as the Great Heart of the universe pulses forth and back in cosmic systole and diastole and is displayed in the Forms evolved as an increasing exhibition of Consciousness from unconscious matter, through the slight consciousness of the plant and the greater consciousness of the animal, to the more highly developed consciousness of human being, who in the completeness of individual evolution becomes freed of Mind and Matter which constitute the Form, and the one with the Supreme Consciousness Itself. The vital phenomena, named as 'Life', appears with organized Matter. Such Life is only a limited mode of Being, which itself is no dead thing but the Infinite Life of all lives.

To the Hindu the difference between plant and animal, and human being, has always been one but differing of degree rather than of kind. There is one Consciousness and one Mind and Matter. While the Matter is organized, the Mind is exhibited in various ways. The Shakti is the Self as the 'String' (Sutratma) on which all the Beads of Form (limited modes of Herself as the 'String' ) are strung. Evolution is the loosening of the bonds in which Consciousness (itself) is fully exhibited as the process held.

Shakti who is pure blissful Consciousness (Cidrupini) in Herself, is the Mother of Nature, born of the creative play of Her thought. The Shakta faith, or worship of Shakti, is one of the oldest and most wide-spread religions in the World. The ancient distinguishing character of the faith is instanced by temple worship (the old Vaidik worship in the home or in the open by the river), the cult of images of Linga and Yoni, the worship of Devis and the Magna Mater (the great Vaidik Devata is the male Indra). The belief in Shakti or the Divine Power, being in female form is distinguished from the Divine Essence (Svarupa).

Lao-tze or the "old master" was twenty years senior to Confucius and his life was said to have been passed between 570-490 B.C. He wrote the Tao-tei-king, the fundamental text of Taoism. This title means Treatise on Tao and Tei. Lao-tze calls Tao, "The great" in its Sanskrit equivalent Brahman and Tei is the power or activity or Shakti. Lao-tze did not invent Taoism no more than Confucius (557-419 B.C.)but invented Confucianism. It is characteristic of the Ancient Eastern Masters that they only claim themselves as "transmitters" of a wisdom older than themselves. Lao-tze was not the first to teach Taoism. He was the writer of the first book on Taoism which served as the basis for the further development of the doctrine and formulated the system from the the pre-Taoists, who had been the analysts and astrologers of the Tcheou.

There is no word in the English language which adequately describes cit, which is not just the mind itself but rather what is behind the mind, by which the mind has created thought. The Brahman is mindless (Amanah). Excluding mind excludes all forms of mental process, conception, perception, thought, reason, will, memory, and particular sensation leaving Consciousness, Feeling, and Experience. Maya is not an unconscious (jada) principle but a particular Shakti of Brahman. While Shakti is basic consciousness, Maya-Shakti is the veiling Consciousness, who is Shiva or Cit in that particular aspect as the material cause (Upadanakarana) in creation, that is real.

There is a direct causal nexus between Shiva as Shakti (Cit-Shakti and Maya-Shakti) and the universe. Shiva as Shakti is the cause of the universe in the form of Jiva (all manifested evolved forms). Shiva as Shakti creates the Universe by evolving into it, and appears as Jiva. There are two principles or aspects in the Brahman, namely Prakasha or Cit aspect, and Vimarsha Shakti, the potential Idam, that explicates into the Universe in creation. Vimarsha Shakti has two states in Its supreme form: The subtler state is in the form of consciousness (Cidrupini) and the gross state is in the form of the Universe (Vishvarupini). Vimarsha Shakti, in the form of consciousness (Cidrupini), becomes one with Cit. The Aham and Idam, are in undistinguishable union with Cit and Cidrupini, in supreme Shiva, as well as still continuing to be in the supreme experience at the same time.

The mutual relation, whether in manifestation or beyond it, is an inseparable connection or inherence (Avinabhava-sambandha, Samanvaya) such as that between "I-ness" (Ahanta) and "I" (Aham) . The terms "formless," "subtle," "dark," "empty," all denote the same unmanifested state in which Shakti is in undistinguishable union with Shiva, the formless consciousness. In the dissolution of the Universe, The supreme state of Shakti returns to the condition of Brahman" (Brahmabhavam brajate), which takes place in the same way as a conflagration, when no more combustible matter remains, she returns again to the latent condition of fire (Vahni-bhava). There is the same fire in both cases but in one case there is the activity of combustion and in the other there is not.

The Aham is the Self as Cit and the Idam is provided by Cidrupini-shakti. Shakti is always the object of the Self since there is nothing but the Self. In the supreme experience the object is one in nature with Shiva. Birth means 'manifestation' to consciousness. There is nothing but Cit. The Aham and Idam exist in an unitary state. Shakti Tattva is called negative because negation is the function of Shakti (Nishedha-vyapara-rupa Shaktih). The universe is a product of negation. Shakti negates the pure experience or consciousness to the extent, that it appears to limited itself. Shakti disengages the unified latent elements (Aham and Idam) in the Supreme Experience as an undistinguishable unity.

The Shiva Tattva is Prakasha-matra to use the imagery of the plane, an "I" without a "This". This is a state in which the unitary consciousness is broken up to the extent, that it is no longer a Perfect Experience in which the Aham and Idam exist in undistinguishable union, but there is only one Supreme Aham Consciousness, as the root of all limited subjectivity. Shakti gradually unveils Herself as the Idam or Vimarsha aspect of consciousness. The result is Sadakhya Tattva, the first evolved produced consciousness from Shiva and Shakti, then an Aham and Idam aspect of experience. In the Jiva consciousness (Jivatma) the object (Idam) is seen as something outside and different from itself. In Sadakhya Tattva and all the subsequent pure Tattvas, Ishvara Tattva and Shuddhavidya Tattva, the "This" is experienced as part of the Self and not as separate from it. There is no outer nor inner.

The circle which represents the one Consciousness is divided into "I" and "This". This is called the "Nimesha" or "closing of the eyes" of Shakti because it is the last stage in dissolution before all effects are withdrawn into their first cause. Being the last stage in dissolution is the first in creation. Then the Idam side becomes clear in the next evolved Ishvara Tattva in which the emphasis is on the "This" which the Aham subjectifies. This is the "Unmesha" or "opening of the eyes" state of Shakti, the first fully equipped state of consciousness to create and do so. The result is again the evolved consciousness called Shuddhavidya Tattva in which the emphasis is equal on the "I" and "This".

Consciousness is the state in which the two halves of experience are ready to be broken up and lived separately. It is at this state that Maya-Shakti , defined as the sense of difference (Bhedabuddhi) and the power by which things are seen different from the Self in the dual manifested World, intervenes through its power. The operation of Maya are limitations of the natural perfections of the Supreme Consciousness. At this stage the Aham and Idam are completely severed. Each consciousness regards itself as a separate 'I' looking upon the "This" whether its own body or that of others as outside its consciousness.

Mind and Matter are ultimately one, the two being the twin aspects of the Fundamental Substance or Brahman and Its Power or Shakti. Spirit is the substance of mind-matter. In Reality, all Appearance is fashioned not by the individual mind and senses but by the cosmic mind and senses. Whatever creates perceives. Power is both to Be and to Become. Shakti is not manifested in its own true nature (Svarupa), that is, Being, Feeling, Consciousness-Bliss (Cinmayi, Anandamayi).The multiple masks (Persona) are the varied forms of mind-matter.

Prana is Shakti is the universally pervading source of life, organizing itself as matter into living forms and represents the involuntary reflex action of the organism. Breathing is a manifestation of the Cosmic Rhythm to which the whole universe moves and according to which it appears and disappears. Prana is a name of the Shakti displaying itself in the organization of matter and the vital phenomena which bodies, when organized and exhibit. The Manifestation of Shakti is vitality, a limited concrete display in forms of Her own formless Being.

Prana, as Shakti, is consciousness that limits Itself in form which it first creates and sustains; then builds up into other more elaborate forms and sustains until their life-period is run. All creation and maintenance is a limited power, with the appearance of unconsciousness, to the degree that, it confines the boundless Being-Consciousness-Bliss. Power is nothing but Consciousness negating and limiting itself.

According to Indian views, there are three states of consciousness:

(1) a supramental supreme consciousness dissociated from mind. This is the Paramatma Cit which is the basis of all existence, whether organic or inorganic, and of thought;

(2) consciousness associated with mind in organic matter working through its vehicles of mind and matter;

(3) consciousness associated with and entirely veiled by inorganic gross matter (Bhuta) only; such as the muffled consciousness, evidenced by its response to external stimuli. The Consciousness (Cit-Shakti) exists in all the hierarchy of Being.

In inorganic matter, Consciousness is so greatly veiled and the life force is so restrained that the insensibility, inertia and mechanical energy appear. Consciousness itself does not change. It remains the same throughout. What does change is, its wrappings, unconscious. In gross matter the light is so turned down that can not ordinarily perceptible not even by delicate scientific experiment. When the veiling is lessened in organic life, the same Consciousness manifests in its freer environment in a sensation associated with consciousness as a mere mechanical reaction.

Shakti, who negates Herself as Maya-Shakti, more and more reveals Herself as Cit-Shakti. There is a progressive release of Consciousness from the bonds of matter, until it attains complete freedom or liberation (Moksha) or Pure Consciousness. At this point, the same Shakti, who had operated as Maya, becomes Herself the Consciousness (Cidrupini). ShivaShakti associated with Maya-Shakti is the state produced by such action, and the source of movement and change. The creative Shakti is changeless Cit-Shakti and changing Maya-Shakti.

The One Shakti is never conceived as existing apart from, or without the other, they are only twin aspects of the fundamental Substance (Paravastu). Shakti comes from the root "shak," "to be able," "to have power". It may be applied to any form of activity. The power to see is visual Shakti, the power to burn is Shakti of fire. These are all forms of activity which are ultimately reducible to the Primordial Shakti (Adya Shakti) whence every other form of Power proceeds. Power (Shakti) and the possessor of the Power (Shaktiman) are one and the same.

In the supreme transcendental changeless state, Shiva and Shakti are one, and Shiva is never without Shakti. Consciousness is never without its Power, that is active Brahman. Since there is no activity then, they exist in the supreme state as one Tattva (Ekam tattvam iva); Shiva as Cit, Shakti as Cidrupini. This is the state, where the origin of all those currents of force form the universe. Cit-Shakti or as Cit as Shakti, and Maya-Shakti or Maya as Shakti are two chief forms of Shakti. In truth the whole world is the Self whether as "I" (Aham) or "This" (Idam). The Self thus becomes its own object or form that may enjoy dualistic experience the union of the static and kinetic aspects of the one Ultimate Reality as Shiva and Shakti, of God and His Power.

Energy (Shakti) polarizes itself into two forms: static or potential (Kundalini) and dynamic (the working forces of the body as Prana). Behind all activity there is a static background. The static center in the human body is the central Serpent Power in the Muladhara (Root-support), that is the static support (Adhara) of the whole body and all its moving Pranik forces. This Center (Kendra) of Power is a gross form of Cit or Consciousness and the highest manifestated form of Force by appearance. There is a distinction (though identical at base) between the supreme quiescent Consciousness and Its active Power (Shakti). When Consciousness manifests as Energy (Shakti), possesses the twin aspects of potential and kinetic Energy.

In the human body the potential pole of Energy is the Supreme Power supported by the moving forces (dynamic Shakti) and stirred to action. The whole engendered dynamism thus moves upward to unite with the quiescent Consciousness in the Highest Lotus. There is a polarization of primordial Shakti into two exhibited forms, static and dynamic. Cosmic energy is in a non- absolute, but relative equilibrium. The positive and negative charges hold each other so that the atoms are in a condition of equilibrated energy and do not break up, though they may do so on the dissociation which is the characteristic of all matter, clearly manifested in radioactivity of radium.

In the tissues of the living body, the operative energy is polarized into two forms of energy -- anabolic and catabolic, the one tending to change and the other to conserve the tissues. The actual condition of the tissues being simply the resultant of these two co-existent and concurrent activities. Shakti, is manifested by dividing itself into two polar aspects -- static and dynamic. The Divine Mother moves as the Kinetic Shakti on the breast of Sadashiva who is the static background of pure Cit (actionless (Nishkriya)) and the Gunamayi Mother being all activity. The Kundali in particular bodies is the Vyasti (individual) Shakti.

Shakti, in a static form at rest is never exhausted, nor emptied into any of its forms. In the First standard, Mind and the so-called "atoms" of Matter are separate, distinct and independent. Matter does not derive from Mind nor the latter from the former. In the Second Standard, both Matter and Mind are equally real, but derive from a common source the Psycho-physical Potential. 'Psychic' here means Mind as distinct from Consciousness in the sense of Cit. This Psycho-physical Potential is Real, independent of Consciousness which is the other Real. In the Third Standard as non-dual Vedanta , the position is the same, except that the Psychophysical Potential is not an independent Real . The world is Real in the sense that it has true objective Reality for the individual Experiencers for the duration of their experience. (216-219)

[**Reflexology**](https://www.sciencedirect.com/topics/nursing-and-health-professions/reflexology) **and Osteopathy**

[Reflexology](https://www.sciencedirect.com/topics/nursing-and-health-professions/reflexology) is a complementary therapy focusing mainly on the application of pressure on the feet, hands and ears. The main theoretical basis of reflexology is centred around the idea that all areas of the body are mapped on to areas of the feet and hands.

[Reflexology](https://www.sciencedirect.com/topics/nursing-and-health-professions/reflexology) was developed from ‘Zone therapy’- first theorised by the American physician William Fitzgerald, who suggested that the body could be divided into 10 vertical equal zones. Theorising that manipulation and pressure techniques conducted on the periphery of these zones in the feet and hands could have an effect on physio-pathological conditions elsewhere in the same vertical zones. This theory is similar to the idea of meridians in acupuncture, just as meridians link one part of the body with another. He discovered that by applying pressure to the tops of fingers with metal clamps and winding tight elastic bands around the middle section of fingers, creates an anesthetic effect on the facial area. Pressure applied to the thumbs of each hand brought relief .Tenderness exhibited in the zones of the foot was thought to reflect a disorder elsewhere in the zone. The dissipation of tenderness in the foot after a short time was accompanied by an associated improvement in affected areas elsewhere in the zone. Zone therapy was the precursor to modern Reflexology.

In its basic form, reflexology consists of a series of thumb and finger movements using applied pressure to the surface of the feet. The technique follows maps of the body which are said to represent every physical area of the body via ‘reflexes’ on the feet, which reflect from the [distal phalanx](https://www.sciencedirect.com/topics/medicine-and-dentistry/distal-phalanx) of the great [toe](https://www.sciencedirect.com/topics/medicine-and-dentistry/toe) (the head) to the calcaneum (pelvis). A series of precise pressure movements are conducted until the whole [surface area](https://www.sciencedirect.com/topics/nursing-and-health-professions/surface-area) has been covered. Depth of pressure and patterns of movement allow for a variety of assorted styles of reflexology.

Fitzgerald was responsible for formulating the first chart showing the longitudinal lines of energy radiating through the body, which he called "Zonal Pathways" The body is divided into 10 zones, one representing each finger and toe. He went on to discover that the application of pressure on zonal pathways via feet, hands, or other body parts not only relieved pain but in majority of cases also relieved underlying causes as well. He added the horizontal zones running across the surface of the hands and feet Fitzgerald also discovered that deep pressure, especially on the feet, stimulated the zonal pathways, improving nerve and blood supply, detoxifying congested areas and reducing pain.

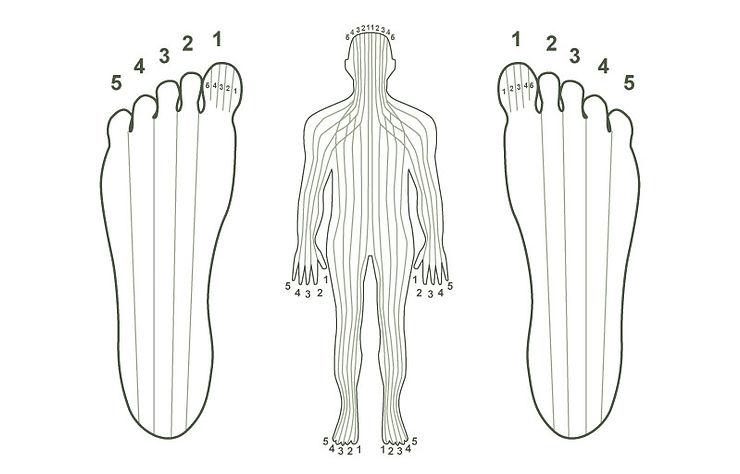


Fig.26. Reflexology points. Referral areas, that are linked to one limb or joint of the body to another through the zones, are utilized to block pain and speed recovery of other injuries to the limbs and joints.

The arm is a reflection of the leg, the fingers correspond to the toes, the hand to the foot, the wrist to the ankle, the forearm to the calf, the elbow to the knee, the upper arm to the thigh, and the shoulder to the hip

Vita Flex (1,500 Vita Flex points) means vitality through the reflexes. "Maps" formed on the feet by Reflex areas, approximate to the body's anatomy (helps identify different structural and health needs) on a complete network of reflex points that stimulate all the internal body systems - an electrical charge is released that sends energy through the neuroelectric pathways. Electrical charge follows the pathways of the nervous system to the break in the electrical circuit related to an energy block caused by toxins, damaged tissues, or loss of oxygen .

* Spine reflex area lies on the inside of the foot and the shoulder reflex area on the outside.
* Solar plexus is the 2nd reflex area next to the spinal reflex

**Right Sole**

* The reflex areas that relate to the body's right side

**Left Sole**

* The reflex areas that relate to the body's left side

**Top of Left Foot**

* Reflex areas that relate to the left side of the body (Lungs, chest, breast, and upper back).The chest and lungs lie "behind" the back, so the chest and lungs reflex areas actually lie behind the back reflex area.

**Inside of Foot**

* The neck is represented at the big toe
* The area between the shoulder blades in the ball of the foot
* The lower back at the arch
* The tailbone at the base of the heel

**Top of Right Foot**

* A point halfway down the foot is known as the "waistline"
* the lymph glands and the groin reflex areas wrap around the ankle

**Outside of Foot**

* Top of the shoulders run across the toes

***From Zone Therapy to Reflexology***

Eunice D. Ingham, who was fascinated by the concept of zone therapy, started developing her foot reflex therapy in the early 1930s. She determined that the reflexes on the feet are an exact mirror image of the organs, functions and structures of the human body. While Zone Therapy relied solely on the zones to identify the areas to be worked, Reflexology isolated specific areas within the zones that stimulate particular parts of the body.

***Zones in the Body***

Energy flows in 10 zones that run the length of the body from head to toe zones throughout the body. Five on each side of the body ending in each foot and running down the arms into the tips of the fingers (body divided into 5 zones on either side of the spine) . Zone 1: Big Toe, Zone 2: Second Toe, Zone 3: Third Toe, Zone 4: Fourth Toe, Zone 5: Fifth Toe. Zones not only run lengthwise, but pass through the body, so that a zone located on the front of the body can also be reached from behind. All organs and parts of the body lie along these zones. A sensitivity in any one spot of the foot creates an imbalance throughout the entire length of that zone.

By stimulating or "working" any zone in the foot by applying pressure with the thumbs or fingers affects the entire zone throughout the body. Reflexology, as an ancient therapy that was used by the early Chinese, Egyptians, and North American indigenous tribes for healing, but it was not until the 19th century that the medical community, nursing, and complementary and alternative medicine (CAM) practitioners began to explore it scientifically. Reflexology is also known as regional therapy and reflex massage therapy. Its principle is that each area of the hands and feet represents each part of the body, such as the heart, liver, spleen, lungs, kidneys, and other internal organs, and when various areas of the hands and feet are massaged, they stimulate energy, blood, nutrition, or nerves, resulting in therapeutic effects, including relieving mental stress, detoxifying the body, promoting blood circulation, losing weight, delaying aging, and improving internal health.

Two internationally recognized reflexology methods are the Ingham and the Rwo Shur method. The Ingham method is performed without using any tools, while the Rwo Shur method uses tools such as wooden sticks.  Most clinical studies have found that foot reflexology is effective in reducing pain, including headache pain, back pain, joint pain , cesarean pain, acute pain in infants , pregnancy pain, labor pain, leg edema in pregnancy, postpartum women’s fatigue, pain from surgical medical examinations , organ removal or transplant pain , various cancer pains , musculoskeletal cases, strokes, insomnia, asthma, diabetes, premenstrual syndrome, dementia, cancers, multiple sclerosis, and idiopathic detrusor overactivity. It has also been studied for use in hospice units to alleviate discomfort and pain in patients at the end of life .

There are three main types of reflexologies: foot, hand and ear. Each type of reflexology involves applying pressure to specific points on the body. In its gentlest form, reflexology can induce relaxation and improve the quality of sleep. Research indicates that there are brain alterations during a reflexology session, emitting cerebral activity in brain waves usually seen in a sleep state. Those undergoing reflexology treatment entered a sleep state within minutes of the treatment beginning. Studies which reviewed reflexology and sleep in ill health appear to show beneficial outcomes. Relaxation and the quality and quantity of sleep, has a range of healing benefits for the immune system, for cognitive functioning as well as relief from anxiety and depression, adaptation to circadian rhythms, improvements in digestion and alleviation of pain.

The way that reflexologists perform their treatments may include the use of relaxing music, subtle lighting and aromatic essential oils. These performances may instigate relaxation which could influence the functioning of physical and emotional health. The accuracy of the chosen point, the length of time and depth of activity on the point and the [environmental factors](https://www.sciencedirect.com/topics/medicine-and-dentistry/environmental-factor) ,all play a part. Part of any reflexology treatment including stroking, massaging, and manipulation of soft tissue, is a hands-on touch. The beneficial nature of human touch has been well documented as a tool to promote healing and bring comfort.

Researchers developed a robotic device engineered to deliver the same amount of pressure on foot reflexes in the same pattern as a standard reflexology session. Results showed that the machine delivered reflexology could still yield positive outcomes despite the removal of the human factor, with symptom severity scores reducing in a small sample of breast cancer patients undergoing chemotherapy.

The dictionary definition of the placebo effect is ‘A positive therapeutic effect claimed by a patient after receiving a placebo believed by him/her to be an active drug’ . There have been a number of well documented cases of profound physiological effects occurring through the power of suggestion alone. In a therapeutic setting, there is the potential for expectation and conditioning to create the conditions for improvement in outcomes. Trust in the reflexologist along with acceptance of their frameworks of explanation and the expectation of a beneficial outcome are all important factors. There is a certain ceremony in the cleansing of the feet, the taking of a [medical history](https://www.sciencedirect.com/topics/nursing-and-health-professions/medical-history), and the explanatory discourse used by the reflexologist, that creates an encouraging and reassuring environment.

Fascia is a thin membrane or fibrous sheath which covers and separates organs in the human body. It has long been considered to be an inert structure, but there is growing interest in the capacity of [fascia](https://www.sciencedirect.com/topics/medicine-and-dentistry/fascia) and fascial manipulation to facilitate a range of effects on discrete areas of the body. There are reflexology points within and around the feet and hands that appear to correspond with areas of meridian lines, which correspondingly map to fascial planes and impacts which range from mechanical to electrical, and from musculoskeletal to molecular. The number of effects of reflexology are ranging, from relief from pain to improvements in digestive or hormonal functioning, through the potential influence of fascial changes instigated during a reflexology session.

A complete anatomical definition described fascia as a system that “surrounds, interweaves between, and interpenetrates all organs, muscles, bones and nerve fibres, endowing the body with a functional structure, and providing an environment that enables all body systems to operate in an integrated manner.” . Such a definition provides a picture of a much larger multi-directional network of fascia and its inter-connectedness.Osteopathy is a manual therapy which uses stretching, massaging and manipulation techniques on muscles and joints with a view to preventing ill health and restoring function and wellbeing. [Osteopaths](https://www.sciencedirect.com/topics/nursing-and-health-professions/osteopathic-physician) use techniques of correction and release with an underpinning understanding of the relationship between pain and tension that can be traced back to fascial structures. In 1899 the founder of Osteopathy A.T.Still described [fascia](https://www.sciencedirect.com/topics/medicine-and-dentistry/fascia) as “the probable matrix of life and death.” It has been suggested that pressure on the foot can convert mechanical force into biochemical changes, which are termed as [mechanotransduction](https://www.sciencedirect.com/topics/medicine-and-dentistry/mechanotransduction). This process facilitates changes between the cytoskeletal structure and the [extracellular matrix](https://www.sciencedirect.com/topics/medicine-and-dentistry/extracellular-matrix), producing cellular responses across membranes. The mechanosensitive cells which respond to mechanical forces on the skin involve both physical and chemical communication processes.

In 2006, Langevin proposed a body-wide signalling mechanosensitive network system via Unspecialized anatomical "loose" connective-tissue network throughout the body that would be affected by changes in movement and posture, and altered in pathological conditions (e.g. local decreased mobility due to injury or pain) and [tissue damage](https://www.sciencedirect.com/topics/nursing-and-health-professions/tissue-injury). could be affected by pain from [injury](https://www.sciencedirect.com/topics/nursing-and-health-professions/injury), posture.  Three categories of signals, electrical, cellular and tissue remodeling, each potentially responsive to mechanical forces over different time scales , generate dynamic, evolving patterns that interact with one another.

Since connective tissue is intimately associated with all other tissues (e.g. lung, intestine), connective tissue signaling may coherently influence (and be influenced by) the normal or pathological function of a wide variety of organ systems. Soft tissue fibroblasts form an extensively interconnected cellular network, that have important integrative functions at the level of the whole body. So, the fascia or the connective tissue system is definitively involved in the structural integrity. Understanding the temporal and spatial dynamics of connective tissue bioelectrical, cellular and tissue plasticity responses, as well as their interactions with other tissues, may be key to understanding how pathological changes in one part of the body may cause a cascade of “remote” effects in seemingly unrelated areas and organ systems.

One of the greatest problems of modern medicine is its fragmentation. Connective tissue may be a key missing link needed to improve cross-system integration in both biomedical science and medicine.” Energy flows through the systems and creates the mass of the core structure and gives the life. Any manual medicine practitioner doing techniques such as Osteopathy in the Cranial field, myofascial release or balanced ligamentus technique, take in a way on a journey to experience the interconnected complex interactions between the particle and the wave. The complex biological and energetic systems all interacting in this experience form the life and a more extensive collaboration between biology and quantum physics will be necessary to learn more about these holistic systems and what makes them all interconnected to each other and to the environment.

Changes in the cell or the [extracellular matrix](https://www.sciencedirect.com/topics/neuroscience/extracellular-matrix) can disrupt [mechanotransduction](https://www.sciencedirect.com/topics/neuroscience/mechanotransduction) and lead to altered tissue states and disease. Therapists can use the special properties of fascia by means of sustained pressure through compression, stretching or twisting of the myofascial system to effect a change in the tissues in other systems throughout the body. The conversion of mechanical force into piezoelectric energy via fascia has implications for [neural transmission](https://www.sciencedirect.com/topics/medicine-and-dentistry/neurotransmission) and interactions with the autonomic nervous systems, which may lead to intriguing potential mechanisms for action of reflexology.

The conversion of a mechanical force into a cellular response is an essential part of cellular processing and an increase in mechanical stimuli can trigger the release of Ca++ entry in excitable cells . The rapidly adapting type I and II Meissner and Pacinian corpuscles account for 70% of the receptors found in the sole of the foot and these receptors are thought to respond better to an on/off stimulus. This type of on/off dynamic pressure is typically applied during a reflexology treatment. Mechanical force influences a range of cellular and molecular activity within biological tissues. Piezo2 ion channels expressed in [Merkel cells](https://www.sciencedirect.com/topics/medicine-and-dentistry/merkel-cell)  [release proteins](https://www.sciencedirect.com/topics/medicine-and-dentistry/protein-secretion) that transduce basic stimuli into [nerve impulses](https://www.sciencedirect.com/topics/neuroscience/nerve-conduction), along with the *A* β neurons that are critical in the sensation of light-touch.

The variety of ways in which pressure on the fascia of the foot can alter functionality in the body, claim benefits which range from improvements in muscular tension and pain to hormonal balance and digestive functioning akin to mechanotransduction. The plantar fascia on the sole of the foot manipulated during reflexology, links to the [Achilles tendon](https://www.sciencedirect.com/topics/medicine-and-dentistry/achilles-tendon) which sits within the superficial back line of fascia, tracing up the back of the leg, onwards to the spine and then over the back and top of the head to the brow. The myofascial transition of plantar fascia-gastrocnemius; gastrocnemius-hamstrings; hamstrings-lumbar fascia/erector spinae/occipito-frontalis is of particular interest for the reflexologist. Working the reflexes on and around the plantar fascia, adjustment and release occurs all the way up from foot to head.

The network of collagenous tissues that make up the variety of fascial matrices allow the dissipation of mechanical forces throughout the body. [Physical therapies](https://www.sciencedirect.com/topics/nursing-and-health-professions/physiotherapy)  have a direct effect on muscular tension just beneath the skin and proper functioning restored, but there is much more to the impact of pressure on skin, both in terms of the transmission from surface to deep tissues, and further into the cells themselves. This suggests that all varieties of manual therapy, including reflexology could have an effect on cellular activities.

Studies into fascia-therapy have indicated positive changes can be brought about in vascular parameters, such as blood turbulence within the arteries. Blood turbulence can occur when arteries are affected adversely by the accumulation of plaques associated with cardiovascular diseases like [atherosclerosis](https://www.sciencedirect.com/topics/medicine-and-dentistry/atherosclerosis). These plaques on the sides of the artery act like buffers in a pinball game, pushing the blood from one side to the other impeding smooth flow. There is evidence that [haemodynamic effects](https://www.sciencedirect.com/topics/medicine-and-dentistry/hemodynamic) can be brought about through reflexology points in the feet.

Both reflexology and [osteopathy](https://www.sciencedirect.com/topics/medicine-and-dentistry/osteopathic-medicine) are activating mechanical forces to achieve similar outcomes in discrete areas of the body. One of the founding osteopathic principles is the “*rule of the artery is supreme*”, such that any obstruction of [blood supply](https://www.sciencedirect.com/topics/medicine-and-dentistry/vascularity) may lead to disease. [Osteopathic manipulation](https://www.sciencedirect.com/topics/nursing-and-health-professions/osteopathic-manipulation) can affect [blood flow](https://www.sciencedirect.com/topics/nursing-and-health-professions/blood-flow) via the autonomic nervous system, and by a reduction in tension via the fascia . Arteries and veins pass through the fascia and may be compromised by fascial restrictions. [Osteopathic manipulation](https://www.sciencedirect.com/topics/medicine-and-dentistry/osteopathic-manipulation) of fascial restrictions can aid fascial sliding and improve blood flow dynamics .

Proprioception is the body's ability to sense where all of its body parts are relative to each other and to objects in the immediate environment. Reflexology involves correction of [proprioception](https://www.sciencedirect.com/topics/medicine-and-dentistry/proprioception), as part of the rebalancing process. Studies have shown that the retinacula of the ankle and foot are rich in nerve fibres and proprioceptors because of their attachments to bone, muscle and to fascial expansions as well as tendons . This activity in the foot and ankle delivers signals to the brain about spatial positioning and effective movement in space, so working on the foot and ankle during reflexology may have potential for instigating change and affecting balance.

Indications from research into the structure of the ankle retinaculum are suggesting that far from being a separate structure involved only in stabilising the ankle and lower limb, the retinaculum which wraps around the ankle is a thickened part of a much greater whole. This whole fascial system from the plantar surface of the foot, through the ankle and onwards up the [skeleton](https://www.sciencedirect.com/topics/medicine-and-dentistry/skeleton) is crucial in the balancing and stability of the whole musculo-skeletal system. People may be benefitting from the process of structural realignment for the relief of pain.

Researchers exploring the mechanisms involved in touch identified that two ion channels (Piezo1 and Piezo2) are directly activated by the exertion of pressure on cell membranes. Essential for the sense of touch, these ion channels have been shown to play a key role in proprioception – the sense of body position and motion, and in regulating additional important physiological processes including blood pressure and [urinary bladder](https://www.sciencedirect.com/topics/medicine-and-dentistry/bladder) control. The usefulness of reflexology in bladder control led to speculation that the mechanism of action in this case may be related to the activation of these ion channels and mechanical force being converted into initiation of the [nervous system](https://www.sciencedirect.com/topics/neuroscience/nervous-system).There are many physiological changes at work in the human body that relate to pressure and force.

It has been reported that pressure between 4 and 8 kPa impairs cutaneous blood flow and an exchange of ions or electrical activity in the cell membrane is generated by tissue deformation that is directly related to the degree of compression. The stronger the stimulus, the higher the frequency and the greater are the chances of initiating an action potential . Mechanical loads induced within or outside the body can increase or decrease the properties of living cells. The type of loading exerted at tissue level is transmitted to individual cells to affect physiological function. The small nerve fibres (A∂ and C-fibres) are known to respond to pressures of between 6 and 24 kPa, which are the typical values exerted during a reflexology session.

The Piezo1 channel is responsible for detecting and transducing subtle changes in force. The Piezo2 channel is a stretch-gated ion channel, responsible for light touch, vibration, and proprioception. Piezo2 receptors, present in [sensory neurons](https://www.sciencedirect.com/topics/neuroscience/sensory-neuron) and the fascial tissue have a rich supply of sensory neurons that evaluate mechanical forces from both the external and internal environment. Evidence has shown that applied pressures in reflexology have a definitive benefit for health and wellbeing. Proprioceptive mechanisms are used on a daily basis to ensure the position of the joints in space. The mechanistic approach of reflexology bears on those processes. Pain can be negatively influenced by emotional stresses, and conversely any relaxation response may have the reverse effect. The alleviation of pain is linked to the empathy shown by the therapist, for example empathetic comments were shown to modulate the effects of pain. Other factors which may influence the alleviation of pain are the effects of touch or distraction.

The manipulation of fascial layers during reflexology may also have something to add about the alleviation of pain, especially pain associated with inflammation. Cells known as fibroblasts existing in deep fascial structures, play an essential part in the regulation of inflammation, and the dysregulation of these fibroblasts has been implicated in [chronic inflammation](https://www.sciencedirect.com/topics/medicine-and-dentistry/chronic-inflammation) . Fibroblasts produce collagen which is a pre-requisite for remodelling and for tissue repair. Researchers have discovered specialised fibroblasts called fasciacytes that produce [hyaluronan](https://www.sciencedirect.com/topics/nursing-and-health-professions/hyaluronic-acid), a [glycosaminoglycan](https://www.sciencedirect.com/topics/neuroscience/glycosaminoglycan) which helps to lubricate joints and allow for sliding between layers of fascia. The quantity of hyaluranon varies throughout the body with greater amounts surrounding joints, the ankle retinaculum where greater movement is necessary. Hyaluranon regulates inflammation and tissue repair and acts as pro or anti-inflammatory depending upon its molecular weigh. Manipulative treatments, and the use of mechanical transduction which instigates a piezoelectric response, may stimulate the activity of fibroblasts causing them to proliferate and reduce the pain associated with inflammatory conditions such as [fibromyalgia](https://www.sciencedirect.com/topics/neuroscience/fibromyalgia) .

The technique of Positional Release (initially known as Strain-Counterstrain) developed by American [osteopath](https://www.sciencedirect.com/topics/nursing-and-health-professions/osteopathic-physician) Lawrence Jones in 1955, in conjunction with fascial release has been shown to reverse [inflammatory cell](https://www.sciencedirect.com/topics/medicine-and-dentistry/inflammatory-cell) behaviour within 60 s of application. Reflexologists who use twisting and stretching reflexology techniques on the foot and ankle may well be tapping into the same processes.Research has shown that lower leg wound healing can be improved by [osteopathic treatment](https://www.sciencedirect.com/topics/medicine-and-dentistry/osteopathy) . This improves the removal of [inflammatory mediators](https://www.sciencedirect.com/topics/medicine-and-dentistry/inflammatory-mediator) such as cytokines, [bradykinin](https://www.sciencedirect.com/topics/medicine-and-dentistry/bradykinin), and [prostaglandins](https://www.sciencedirect.com/topics/neuroscience/prostaglandin). [Lymphatic drainage](https://www.sciencedirect.com/topics/medicine-and-dentistry/lymphatic-drainage) also decreases autonomic nervous system activity due to decreased afferent input to the spinal cord. [Interstitial fluid](https://www.sciencedirect.com/topics/neuroscience/interstitial-fluid) movement has been shown to be activated by osteopathy, and changes in the quality and viscosity of fluid have also been demonstrated within the fascial network. Reflexology treatment facilitates and improves [lymphatic flow](https://www.sciencedirect.com/topics/nursing-and-health-professions/lymph-flow) through the deep fascial layers. It is feasible that the movement of lymph in [breast cancer related lymphoedema](https://www.sciencedirect.com/topics/nursing-and-health-professions/breast-cancer-related-lymphedema) is propelled through the deep fascial layers when encouraged by reflexology on the feet and ankles.

Osteopaths have been concerned with fluid dynamics and fascia. Research has investigated the role and importance of fluid dynamics and water in fascia. The body is composed of 60% water; Aging makes loose water. At birth the percentage of water in the body is 75–80%, by age 25 it is 60% and by the age of 80 years of age, it is only 50%. Water is a prerequisite for [homeostasis](https://www.sciencedirect.com/topics/medicine-and-dentistry/homeostasis) as a result of nutrients being conveyed to the cells and cellular waste being evacuated and acts as a solvent, a thermoregulator, a [shock](https://www.sciencedirect.com/topics/medicine-and-dentistry/shock-circulatory) absorber and a [lubricant](https://www.sciencedirect.com/topics/nursing-and-health-professions/lubricating-agent) . All systems of the body rely on sufficient hydration to operate at an optimum level. Stagnation of dynamic fluid health has been associated with poor tissue health and aging with water being bound to [inflammatory cytokines](https://www.sciencedirect.com/topics/medicine-and-dentistry/inflammatory-cytokine). Research has demonstrated densification of the thoracolumbar fascia and decreased shear in patients with chronic low back pain and , supported the use of fascial release to effect change at the cellular level. The hyaluranon molecule is extremely hydrophilic. [Osteopathic manipulation](https://www.sciencedirect.com/topics/nursing-and-health-professions/osteopathic-manipulation) of fascia involves a very slow shearing motion in multi-directional vectors, to promote hyaluranon production and consequent increased [water content](https://www.sciencedirect.com/topics/nursing-and-health-professions/water-content) to promote fascial sliding and decreases fascial densification .Connecting with reflexology at all stages of health and illness can provide immediate benefits such as improvements in pain, anxiety, restorative sleep and general wellbeing.

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The influence of fascia in structural, cellular, and movement of lymph has important clues for the understanding of reflexology outcomes.The mechanism of action for reflexology is highly dependent upon the therapeutic touch, placebo, personal empathy and physical pressure and manipulation. Whilew aspects of placebo and therapeutic touch are considered as essential agents in the outcomes of reflexology, the role of fascia should be also considered as a potential theory of mechanism for the deeper manipulative techniques of reflexology treatment, both in the maintenance of structural integrity in the [musculoskeletal system](https://www.sciencedirect.com/topics/medicine-and-dentistry/musculoskeletal-system) and in the potential impact on [pain modulation](https://www.sciencedirect.com/topics/medicine-and-dentistry/pain-modulation), fluid movement and cellular activity.



Fig.27. Foot reflexology chart

On the physical, emotional, and spiritual levels, reflexology often improves individuals’ physical health and well-being. People choose reflexology because:

1. It does not use any drugs or chemicals and is the best choice for many health problems;
2. It can reduce pain;
3. It helps maintain physical flexibility and athleticism;
4. It relaxes the limbs, especially the hands and feet, and the whole body;
5. It stimulates the body to release pain-relieving chemicals;
6. It can be used as a means of preventing disease;
7. It promotes recovery from physical injury, especially for the hands and feet ;
8. It triggers the release of endorphins and enkephalins, which help relieve pain and improve mental energy and well-being .

*Structural reflexology, which is the practice of integrating foot reflexology with anatomy, physiology, and kinesiology by using local and reflexive methods to release stress and compensation in the entire body including myofascial work, pnf stretching (proprioceptive neuromuscular facilitation, compression with active engagement, and attention to muscles tendons and ligaments, aims to reduce stress and addresses tension sites on the feet as the product of local muscle and ligament strain while maintaining an understanding of how these sites of tension on the feet will impact the rest of the body.*

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*Benefits of Structural Reflexology:*

* *Improve foot joint articulation.*
* *Improve weight bearing & balance.*
* *Improve blood and nerve supply to feet & body.*
* *Relieve compensation in feet and body.*
* *Relieve joint tension.*
* *Increase strength and vitality in feet & body.*

*Primary Goals of Structural Reflexology:*

* *Reduce stress in feet and body.*
* *Overcome joint tension in feet.*
* *Relieve muscle strain.*
* *Increase joint function.*
* *Bring foot back to a stage that is comfortable.*

*Structural Reflexology has 3 sequences:*

*massage - preparing*

*reflexology - working up the muscles and attachments*

*Passive foot mobilization -*

*Primary Goals of Structural Reflexology:*

* *Reduce stress in feet and body.*
* *Overcome joint tension in feet.*
* *Relieve muscle strain.*
* *Increase joint function.*
* *Bring foot back to a stage that is comfortable.*

*Ideally, flexible, lightweight and are foot shaped with more cushioning shoes, mimic barefoot function, fit the shape of the foot, and be flexible to meet the parameters of maintaining healthy, strong, functional feet. Toes should be able to wiggle freely in them.* (220-223)

**COLLECTIVE REFLEXOLOGY**

According to Sigmund Freud’s psychoanalytic theory, life events and social factors influence mental disorders. Bekhterev, took the reflex arch of the conditioned reflex, (afferent – integrating centre – efferent ) as the basis of his concept and emphasized that exogenous factors , that means the milieu mainly shapes human behaviour. shapes human behaviour. The governors are capable of turning the perceptions and thoughts of the masses towards higher aims and noble tasks. After laying the groundwork for his doctrine of reflexology, Bekhterev became interested in the topics of personality, forensic medicine, the behaviour of the masses, and even philosophical aspects in his subsequent works. According to Bekhterev, the shaping of a personality in one’s personal life is mainly based on mental processing of external triggers.

Perpetual hunger leads to passiveness of personality and weakness of character and pauperism and alcoholism are the roots of criminality. A criminal act is influenced by external common factors embedded in the personality, also by factors from the past, such as heredity and individual development. The delinquent is a victim of his social-economic conditions. In the end, those conditions can stress a person’s biological system resulting in degeneration and mental diseases. This would be an example of an objective or ‘psycho-reflexological’ method according to which even thoughts are composed of different reflexes.

Single words and terms may have a cluster structure, i.e. they could be divided into optical, acoustic, haptic compounds. Complex subjective phenomena consist of a complex of reflexes. Socio-economic factors as stimuli may inculcate many reflexes that constitute the superstructure of inherited reflexes in the individual. The utterances and behaviour of a given personality follow a set pattern. A collective is just a collection of individuals joined through common interests .

In ‘collective reflexology’ , the pattern of a primordial reflex is covered by inculcated reflexes to social structures such as society’s domination over individual personalities and the shaping of one’s personality by society . Human needs are just conditioned reflexes. Health conditions, religious views, education levels and work abilities should be considered.

Mass psychology describes crowd behaviour as being due to a ‘collective personality,’ requiring a talented person to lead it. He considered the behaviour of such a collective personality to be based on the same reflexes as those underlying the personality of a single individual. The expressions of a crowd are constitutional in the sense that they follow an internal law or set pattern. Work in a collective has advantages over the work of individual workers, since deviant opinions can be corrected by the collective controls and serious mistakes and excesses can be prevented. Every new form of being is based on primitive forms which determine whatever is new referred as a principle of historical consistency.

Bekhterev’s concept of reflexology describes the relation between external stimuli and the central nervous system and its mental effector as being analogous to the reflex arc. In other words, the theory describes the impact of exogenous factors on affects and behaviour and on mutual interactions of the self and the environment. The impact of social conditions should always be included on mental health. Progress in social and living conditions improves mental health and reduces crime. (224)

**Structural Integration (SI)**

**Structural Energetic Therapy,** a pioneering approach to bodywork, blends the realignment of physical structure with the harmonizing of subtle energies, offering a comprehensive path to healing and rejuvenation.

**Structural Integration (SI)** is a system of manual therapy and sensorimotor education that aims to improve human biomechanical functioning as a whole rather than to treat particular symptoms. It was developed and propagated by the biochemist Ida Pauline Rolf (1896–1979) in the mid- and late 20th century. SI techniques have been adopted by a wide range of other manual therapies, and the method is increasingly resorted to for the treatment of chronic musculoskeletal pain and dysfunction.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3198617/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3198617/#B1)

Rolf Therapy, known as Structural Integration is a transformative bodywork modality, by applying pressure and movement that can help to achieve lasting pain relief, improved posture, better alignment, a renewed sense of physical and emotional well-being and a body that moves with ease. The techniques used in Rolf Therapy are as varied as they are effective from slow, sustained pressure to quick, rhythmic movements. Rolf regarded gravity as a major, lifelong stressor to which all human beings must adapt, and believed that the efficiency of movement or distress inherent in various patterns of adaptation is of great significance for the individual's health and quality of life.  She developed postural and movement ideals to serve as hallmarks of optimal adaptation to gravity (i.e., minimal stress and maximal efficiency). The most prominent of these are alignment of the major body segments—cranium, thorax, pelvis, knees, and feet—in relaxed standing such that the center of mass of each falls along the “gravity line,” the vector of gravitational force that defines vertically. Other guiding ideals are bilateral symmetry, and anterior–posterior “horizontality” of the pelvis, thorax, and cranium. Movement ideals include a uniformity of tonus that allows all activated muscle groups to contribute equally to the work of movement (Rolf called this “grace”), and efficient neuromotor coordination in everyday activities, assessed by the extent of cross-extensor activation in walking (counter-rotation of pelvic and shoulder girdles).

The goal of SI treatment is to progressively approximate the individual's structure and movement to these ideals. Rolf also believed that her method would increase the individual's integration with the Earth's gravitational field, that this would promote “greater psychological ease and emotional security,” and that the “integrated man” would manifest increased “maturity.” She regarded the alleviation of chronic musculoskeletal or other conditions as byproducts of progress toward these more holistic goals. The methods of SI are both manipulative and educational. More gradual and prolonged Manual force with more pressure, than typical massage, chiropractic or osteopathic manipulation, is applied to the soft tissues. The practitioner makes contact with fingertips, knuckles, a closed fist or the flat of the ulna, sustaining pressure until the tissue is felt to “give,” which is taken as an indication that its pliability has increased. In order to increase the area over which soft tissue change occurs, it is asked to perform slow, directed movements as pressure is applied.

Rolf formulated a series of 10 treatments, referred to as “the Ten Series,” as an initial course of therapy. Each lasts approximately 1 hour and focuses on a specific set of biomechanical changes that are intended to advance the overarching ideals. In addition to the particular goals of each session, each also concludes with work that provides additional flexibility to the spine so that vertebrae can realign in response to the changes induced in other areas . Rolf also devised postural and movement awareness exercises that contribute to the goals of each of the Ten Series sessions. Specific, simple movements are performed while directing attention to “landmark” points on the body, which are enhanced by imagery. The exercises are designed to cultivate the ability to discriminate between established habits that entail more versus new patterns that entail less biomechanical strain. They may be supplemented by sessions of Rolf Patterning, a system of movement awareness training that was developed to complement SI treatment.

Rolf suggested two other consequences of local increases in what she believed to be fascial pliability. The first is an increased rate of interstitial fluid flow, which is potentially significant because movement through the soft tissues accounts for a large portion of fluid transfer in the body. The second is that the increased pliability and movement of the myofascial sheets increased the stimulation of sensory nerves and thus enhanced somatosensory perception. Rolf taught practitioners to approach joint pain and dysfunction by comparing the tone and motility of all the soft-tissue structures that are called upon to lengthen and contract as the joint flexes and extends. Pressure is then applied to structures that are visibly less motile than others, resulting in a subsequent increase in their ability to flex and extend.

The entire area both the joint and surrounding tissues subsequently feels less painful, “better,” and “stronger.” Rolf regarded this effect as due to a reduction in mechanical strain resulting from improved tone in the involved soft tissues; that greater equality of tone allows strain to be shared more equally among all involved soft-tissue structures, rather than the few that are more capable of stretch being required to bear excessive strain. Rolf appears not to have posited a more general mechanism for a widely reported reduction in chronic musculoskeletal pain. Significant benefits for a variety of chronic musculoskeletal pain syndromes, are discussed in three ways that SI might reduce nociceptive stimulation.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3198617/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3198617/#B18) Balancing first the pliability of connective tissues in the area of problematic joints can realign force vectors along more physiologic lines by noting that this might also reduce nerve irritation at the joint. Second, SI increases the flexibility of scar tissue, the rigidity of which could be another source of nociceptive irritation. Finally, the increased rate of interstitial fluid flow might relieve local ischemia due to an impaired perfusion that would contribute to local hypoxia, acidosis, and the accumulation of known nociceptive amplifiers such as bradykinins, potassium ions, and prostaglandins.

The most reported whole-body effects of SI, immediately following a treatment, are improvements in posture and motor coordination, and increased overall relaxation. Longer term effects are related to the migration of the patient’s structure and movement patterns toward increased biomechanical efficiency in response to strategic changes in the pliability of the soft tissues and increased somatic awareness. In an electromyographic study of the performance, increases in the rhythmic coherence of motor neuron activation, functional independence of muscles, efficiency of movement, and improved posture were found. The level of structural integration (LSI) originally developed by the Operationalized Psychodynamic Diagnosis (OPD),, as a psychodynamic/psychoanalytic concept associated with the situations, contents and negative emotions in the intersession experiences of patients, as well as their symptom distress over the course of therapy, is a significant predictor of outcomes. Patients with different LSI had different intersession experiences. (225-226)

**Chiropractic Care**



Fig.28. Chiropractic treatment.

Chiropractic treatment for spinal conditions focuses on treating and preventing mechanical disorders of the spine and musculoskeletal system, primarily through hands-on adjustments and manipulations. The basics of chiropractic care for spinal conditions are:

**Spinal Adjustments (Spinal Manipulation Therapy – SMT)**

* **Purpose**: The core of chiropractic treatment is spinal adjustment or manipulation. This involves applying controlled force to specific joints of the spine, particularly where there may be restricted movement, misalignment (subluxation), or dysfunction.
* **How It Works**: Chiropractors use their hands or specialized tools to deliver a quick, precise thrust to the spine to restore proper alignment and mobility. This can help relieve pressure on nerves, reduce inflammation, and improve overall function.

**Spinal Decompression Therapy**

* **Purpose**: This is a non-surgical technique used to relieve pressure on compressed spinal discs and nerves.
* **How It Works**: Chiropractors use a traction device or table to gently stretch the spine, creating negative pressure within the discs. This can help reduce nerve compression.

**Soft Tissue Therapy**

* **Purpose**: In addition to addressing the spine, chiropractors often treat the surrounding muscles, ligaments, and fascia to reduce pain, tension, and stiffness.
* **How It Works**: Techniques like massage, trigger point therapy, and myofascial release are used to target soft tissue dysfunction. These therapies relieve muscle tension and improve blood flow, which can help support spinal adjustments and reduce inflammation.

**Therapeutic Exercises and Stretches**

* **Purpose**: Chiropractors often prescribe specific exercises and stretches to support spinal health, improve posture, and strengthen muscles.
* **How It Works**: Exercises target weakened or tight muscles that may be contributing to spinal problems. For example, core-strengthening exercises help stabilize the lower back, while stretches improve flexibility and range of motion.

**Posture and Ergonomics Education**

* **Purpose**: Poor posture and ergonomics can place unnecessary strain on the spine, leading to pain and injury. Chiropractors often educate patients on maintaining proper posture and ergonomic practices at work or during daily activities.
* **How It Works**: Patients are taught how to sit, stand, and move in ways that reduce stress on the spine. This may include adjusting workstations, lifting techniques, or sleeping positions.

**Instrument-Assisted Adjustments**

* **Purpose**: For patients who may be sensitive to manual manipulation or have conditions like osteoporosis, chiropractors may use instruments to deliver gentler adjustments.
* **How It Works**: Tools like the Activator Adjusting Instrument provide a quick, low-force impulse to targeted areas of the spine. This technique is less forceful than traditional manual adjustments but still effective at improving spinal alignment.

**Lifestyle and Nutritional Counseling**

* **Purpose**: Many chiropractors take a holistic approach to health, including lifestyle factors such as diet, exercise, and stress management that affect the spine and overall well-being.
* **How It Works**: Chiropractors may recommend dietary changes, supplements, or stress-reduction techniques to support spinal health and recovery. For instance, maintaining a healthy weight reduces pressure on the spine, and proper nutrition supports tissue healing.

**Electrical Stimulation (E-Stim)**

* **Purpose**: This therapy is used to relieve pain, reduce muscle spasms, and promote healing by applying mild electrical pulses to muscles or nerves.
* **How It Works**: Electrodes are placed on the skin near the affected area, and a controlled electrical current stimulates the nerves and muscles, improving circulation and reducing pain.

**Ultrasound Therapy**

* **Purpose**: Ultrasound therapy is used to reduce inflammation, improve blood flow, and promote tissue healing.
* **How It Works**: A handheld device delivers sound waves deep into the tissues, generating heat and improving circulation to the affected area.

**Cold Laser Therapy (Low-Level Laser Therapy – LLLT)**

* **Purpose**: This non-invasive treatment uses low-level lasers to stimulate healing and reduce pain and inflammation.
* **How It Works**: The laser device is applied to the skin over the painful area, penetrating deep tissues to stimulate cellular repair and reduce inflammation.

Chiropractic care for spinal conditions is most effective when combined with patient education, therapeutic exercises, and lifestyle modifications. Chiropractic is a health care profession concerned with the management of neuromusculoskeletal conditions and, more specifically, disorders affecting the spine. Arguably, chiropractors' area of expertise lies within the field of spine care and in the application of manual therapy. Chiropractors strongly rely on the use of manual therapy, particularly spinal manipulation (SM), which is the main form of care they provide. A spinal adjustment consists of the application of a high-velocity, low-amplitude controlled thrust force to a spinal segment.

Chiropractors use 4 broad categories of therapeutic interventions:

(a) joint manipulation and mobilization,

(b) soft tissue manipulation and massage,

(c) exercise and physical rehabilitation prescription, and

(d) home care and activity modification advice. In addition, nutritional and dietary counseling, physical therapy modalities (eg, heat, ice, ultrasound, electromodalities), and taping/bracing are also used as adjunct procedures.

The core concepts of chiropractic, subluxation and spinal manipulation, are not based on sound science. “The ‘raison d'être’ of the chiropractic profession is the detection and correction of spinal subluxations.”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib13)

Definitions of Chiropractic

Date Definition/description (quotes)

1998 A system of healthcare which is based on the belief that the nervous system is the most important determinant of a person's state of health.

1994 A drugless, non-invasive manual form of outpatient treatment for musculoskeletal, functional and other chronic disorders.

1996 A therapeutic system based on the premise that structure and function in the human body are closely related and, in particular, the relationship between the spinal column and the nervous system is the most important.

1998 A system of healing based on the belief that health is maintained when the spinal column is in its proper position and the nervous system is not impinged.

1998 Chiropractic is based on the body's ability to heal itself. Central to improving the body's ability to heal itself, chiropractors assert, is the removal, or correction, of malalignments of the spine (called subluxations) through the use of spinal manipulation (called spinal adjustments).

1998 The medical profession that specializes in manual therapy and especially spinal manipulation.

1999 A health profession concerned with the diagnosis, treatment and prevention of mechanical disorders of the musculoskeletal system and the effects of these disorders on the function of the nervous system and general health. There is an emphasis on manual treatments, including spinal manipulation or adjustment. (World Federation of Chiropractic)

1999 A profession which specializes in the diagnosis, treatment and overall management of conditions which are due to mechanical dysfunction of the joints, particularly those of the spine, and their effects on the nervous system. (British Chiropractic Association)

1999 A branch of the healing arts which is concerned with human health and disease processes. (American Chiropractic Association)

2000 A branch of the healing arts based on the premise that good health depends, in part, upon a normally functioning nervous system.

2000 The chiropractic is not a technique. It is a health care profession, it has an exclusive body of information which teaches, certifies, policies, purveys and sometimes attempts to validate.

2003 A form of health care that focuses on the relationship between the body's structure, primarily of the spine and function.

The history of chiropractic is “rooted in quasi-mystical concepts.”  Bonesetters of various types are part of the folk medicine of most cultures,  and bonesetting also formed the basis on which chiropractic developed. The birthday of chiropractic is said to be September 18, 1895. On this day, D.D. Palmer manipulated the spine of a deaf janitor by the name of Harvey Lillard, allegedly curing him of his deafness. Palmer's second patient, a man suffering from heart disease, was also cured.  About one year later, Palmer opened the first school of chiropractic.[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib29)

There is evidence to suggest that D.D. Palmer had learned manipulative techniques from Andrew Taylor Still (1828–1917), the founder of osteopathy.[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib30) He combined the skills of a bonesetter with the background of a magnetic healer and claimed that “chiropractic was not evolved from medicine or any other method, except that of magnetic.”  He coined the term “innate intelligence” (or “innate”) for the assumed “energy” or “vital force,” which, according to the magnetic healers of that time, enables the body to heal itself. The “innate” defies quantification. The “innate” is said to regulate all body functions but, in the presence of “vertebral subluxation,” it cannot function adequately. Chiropractors developed spinal manipulations to correct such subluxations, which, in their view, block the flow of the “innate.”

Chiropractic is “a system of healing based on the premise that the body requires unobstructed flow through the nervous system of innate intelligence.”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib34)   “Innate intelligence” evolved as a theological concept, the representative of Universal Intelligence within each person. Originally, manipulation was not a technique for treating spinal or musculoskeletal problems, it was a cure for *all* human illness: “95% of all diseases are caused by displaced vertebrae, the remainder by luxations of other joints.”  

 Chiropractors envision man as a microcosm of the universe where “innate intelligence” determines human health as much as “universal intelligence” governs the cosmos. Chiropractic “incorporated vitalistic concepts of an innate intelligence with religious concepts of universal intelligence,” which substituted for science.

 Two different chiropractic professions exist side by side—“one that wishes to preserve the non-empirical, non-positivist, vitalist foundations (the straights) and the other that wishes to be reckoned as medical physicians and wishes to utilize the techniques and mechanistic viewpoint of orthodox medicine (the mixers).”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib32)

There is a functional relationship between the spine and health mediated through the nervous system.Subluxations adversely affect health. Correction of subluxation by spinal manipulation improves or restores health. (“vertebral subluxation complex,”  “manipulable spinal lesion,”  “chiropractic lesion,”  or “vertebral blockage,”)[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib58) .[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib13) The term used in chiropractic as“a static malalignment of a single vertebra, means something different from subluxation in regular medicine. ”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib6)  Subluxations are believed to impinge on spinal nerves, blocking the flow of the “innate intelligence” or causing disease in some other way. Atlas subluxations impinge on the spinal cord“. Chiropractic gets sick people well by adjusting vertebral subluxations of atlas and axis only. ;[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib40)   [https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib59)  How subluxations might cause health problems, have been explained  through edema around intervertebral foramina or twisting the dura mater.

The U.S. Association of Chiropractic Colleges reached a consensus in 1996 that “chiropractic is concerned with the preservation and restoration of health and focuses particular attention on the subluxation. A subluxation is a complex of functional and/or pathological articular changes that compromise neural integrity and may influence organ systems function and general health.” One year later, the U.S. Foundation for Chiropractic Education and Research published a monograph stating that subluxation “embraces the holistic nature of the human body, including health, well-being, the doctor/patient relationship, and the changes in the nerve, muscle, connective tissue, and vascular tissues which are understood to accompany the kinesiologic aberrations of spinal articulations.”

Subluxations can be corrected with spinal manipulations or “adjustments,” Spinal manipulation has to be specific, at the correct spinal segment. In its broadest definition, it describes the “application of a load (force) to specific body or tissues with therapeutic intent.”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib20) Spinal manipulation moves vertebrae beyond their physiological range of motion ( “end feel” and “paraphysiological space”)[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib13)  but not far enough to destroy joint structures:[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib6)  “between the normal range of motion and the limits of its normal integrity.”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib13) Chiropractors believe that spinal manipulation breaks fibrous adhesions within joints, or “releases small tags from the joint capsule that might be entrapped within the joint,” or affects the mechanoreceptors of the joint, or modulates central nervous system excitability,  or inhibits C-fiber mediated pain perception. Numerous forms of spinal manipulation exist but “the short-lever technique—touching the vertebrae directly at high velocity and low amplitude, i.e., by moving a small distance—with the spinal or transverse process as a fulcrum, is considered the typical chiropractic manoeuver.”[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib6)

In addition to spinal manipulations, other modalities such as heat, cold, and electrotherapy are also used. Maintenance chiropractic care is promoted as a preventative measure for both musculoskeletal and visceral problems. Chiropractic services are used mostly for the management of musculoskeletal conditions. The American Chiropractic Association stresses that chiropractic care is “not limited to back pain, neck pain” or other neuromusculoskeletal disorders. Nonmusculoskeletal problems regularly treated by chiropractors include respiratory conditions, nonspinal injuries, digestive system disorders, menstrual problems, ear infections, pregnancy-related conditions, infectious and parasitic conditions, dermatological diseases, and acute urinary conditions.[https://www.sciencedirect.com/science/article/pii/S088539240700783X](https://www.sciencedirect.com/science/article/pii/S088539240700783X#bib81) Chiropractors cite uncontrolled studies in support of spinal manipulations for indications such as dysmenorrhea, asthma, otitis media, hypertension, IBS, and peptic disorders Chiropractors diagnose and manage musculoskeletal disorders, commonly using spinal manipulative therapy (SMT). Chiropractic is a health care profession that focuses on the diagnosis and management of musculoskeletal disorders, with an emphasis on those affecting the spine. (227-230)

**Manual therapy**

Manual therapy has been an approach in the management of patients with various disorders dating back to ancient times and continues to play a significant role in current health care. Manual therapy is laying on of hands to apply a force with a therapeutic intent and techniques including massage, joint mobilization/manipulation, myofascial release, nerve manipulation, strain/counterstrain, and acupressure. Hippocrates in the 5th century BC. recommended the use of manual therapy including prone traction with associated spinal manipulation. He demonstrated the effectiveness of various manual techniques and suggested modifications in the delivery of force parameters, such as direction, speed, and frequency of the manipulations including high-velocity thrust techniques. In the 2nd century AD, Galen applied manual medicine to the extremities and spine including massage and joint manipulation. The Renaissance surgeon Ambrose Pare recommended the treatment of thoracic kyphosis to include traction with the use of ropes and boards, and manual pressure over the vertebra.

Manual treatment was further developed in Europe by generations of “bonesetters”, manual practitioners who passed on the art of technique from one family member to another and used it in the treatment of patients with various disorders including extremity joint dysfunction, spinal dysfunction, lymphadema, TMJ disorders, headaches, cystic fibrosis, nerve entrapments, and following immobilization. Manual therapy is also applied to extremity disorders, particularly in the presence of limited mobility. Several investigations have found that manipulation of the extremities may improve movement and decrease pain. The role of manual therapy for patients with carpal tunnel syndrome has been supported. Manipulation of the carpal bones, combined with a manual stretch of the flexor retinaculum in a single cohort study, was found to decrease pain and improve wrist extension range of motion.

Manipulation as a component of rehabilitation post-Colles fracture casting was found in one investigation to result in increased wrist extension and improved pain. Joint mobilization combined with exercise in patients with metacarpophalangeal fractures was demonstrated to be more effective in improving mobility than exercise alone. Cervical manipulation is used to treat head and neck pain and movement disorders. Deep transverse friction massage, a manual treatment technique is used in the management of patients with tendonitis. Traditional systems of manual therapy (TMT), including physiotherapy, osteopathy, chiropractic, and soft tissue therapy have been built on principles such as clinician-centred assessment, patho-anatomical reasoning, and technique specificity.

Some of the most prominent Theories for the mechanisms of action of MT interventions include reductions of disc herniations, repositioning of a bone or joint, removal of intra-articular adhesions, changes in the biomechanicalproperties of soft tissues, central pain modulation, and biochemical changes. Local tissue stiﬀness, which has been observed in people with pain, is associated with neuromuscular responses, rather than patho-anatomical changes at local tissue level. Posteroanterior forces applied during spinal mobilization consistently induce sagittal rotation, as opposed to the assumed posteroanterior translation .

Comfort suggests that both the person seeking help and the therapist are physically and emotionally content during the assessment and therapeutic process. For example, the person seeking help is agreeable with any necessary state of dress (sociocultural diﬀerence should be considered); the person is relaxed and untroubled in whatever position they are in, and is adequately supported whether sitting, standing or recumbent during assessment and treatment; the therapist is comfortable with their positioning and posture; any discomfort produced by the therapeutic process is negotiated and agreed. Any physical mobilisation or touch should be applied with respect to the feedback from the person in relation to their comfort, rather than a pre-determined force based on the notion of resistance. This process requires clinical phronesis, sensitivity, responsivity, dexterity, and embodied communication.

The therapeutic process should be undertaken in a well-organised, competent manner aiming to achieve maximum therapeutic beneﬁt with minimum waste of eﬀort, time, or expense. To enhance the eﬃciency dimension, the assessment and therapeutic process should be an integral part of a holistic educational and/or activity-based approach to the management of the people which might also address psychological, nutritional, or ergonomic aspects of care, while being aware of social determinants to health. A principle of MT is that therapists should not lose sight of the goals they develop with the people they help and ensure that there is coherence between their management aims and their techniques. Therapists should aim to support a person’s self-eﬃcacy and use active approaches to empower them in their recovery. The therapeutic applications should be made in the context of fostering therapeutic alliance and supporting people to make sense of their situation and symptoms and should be informed about the eﬀects of manual therapy, emphasising a “physical education process” to promote sense-making and self-eﬃcacy in alliance with the people they aim to help. (231-232)

**soft tissue therapy” (STT)**

The term “soft tissue therapy” (STT) refers to mechanical methods of treatment involving passive kneading, pressing and stretching of pathologically tense tissues in supporting the process of recovery after surgery or trauma to the musculoskeletal systemThe tissue that constitutes a specific kind of bond, simultaneously co-creating all joint structures, is the connective tissue . The active and passive stabilizers of the knee joint are closely interconnected in the fascial system, which is the soft tissue component of the connective tissue system . The joint capsule of the knee joint is directly influenced by the tendons that attach to it, the gastrocnemius, biceps femoris (BF), and semimembranosus muscles , as well as more distant structures such as the gluteus maximus muscle, tensor fascia lata, and the iliotibial band. The muscles of the lower limb connect to the deep fascia by means of so-called fibrous expansion or indirect insertions in the muscle fibers (muscular insertion) . The fibrous expansions of the quadriceps running from the medial and lateral gastrocnemius muscle fibers, through the anterior part of the patella, connect to the fascia lata of the thigh and participate in the formation of the patellar retinaculum.

The semimembranosus muscle tendon, on the other hand, forms two branches; the first connects to the posterior part of the joint capsule, forming the oblique popliteal ligament, while the second connects to the fascia of the popliteus muscle . Changes and damage to the fascial system play an important role for both the stability of the knee joint as well as the formation of movement restrictions and sensomotor disorders .The deep fascia has long been considered as a source of pain, resulting from changes in its structure (densification and/or fibrosis), causing deformation of nerve endings immersed in the fascia . The hypothesis that the fascia is directly involved in the pain mechanism is supported by experiments using hypertonic saline. After injecting the deep fascia of the dorsal extensor muscle and the thoracolumbar fascia with hypertonic saline (5.8%), subjects reported the onset of acute pain. The findings indicate that the thoracolumbar fascia is the most sensitive structure to chemical stimulation and as such is likely to be the main cause of the development of non-specific back pain. Sensitization of fascial nociceptors play a significant role in the pathophysiology of chronic musculoskeletal pain and sensitized free nerve endings in the muscle fascia continue to be stimulated when the fascia is prestretched by muscle contraction.

Disorders of the fascia structure and its properties can affect function and recovery in chronic pain patients. Loss of the physiological property of fascial expansion, impaired gliding of collagen layers in relation to each other and increased friction between fascial layers, associated with the presence of high levels of abnormal hyaluronic acid (HA) molecules, have been implicated as causes of chronic pain . This is particularly important in the knee joint, where smooth tissue movement is particularly important during the concentric and eccentric contraction phases that occur during each step . The result of reduced tissue gliding is increased tissue tension and stiffness, which can lead to overload and repetitive micro-injuries; if left untreated, can impinge on the development of inflammation, resulting in pain at rest, adhesions, and in the long term, degenerative changes in tissues and even tissue damage. The described loose connective tissue gliding disorders may occur secondarily, as a consequence of trauma, surgery, or overload syndrome. It has been shown that the absolute majority of free nerve endings are very superficially distributed in the fascia and that it contains sympathetic fibers, which may be related to vasoconstriction and ischemic pain .

Changes in fascicle innervation occur as a consequence of pathological changes. It has been demonstrated that patients with patellofemoral conflict and anterior compartment knee pain have proliferation of nociceptive fibers (in the pathomechanim of nerve ingrowth) and immunoreaction to substance P within the shortened, compressed lateral knee retinaculum. The referenced findings support clinical observations indicating that retinaculum pathology play a key role in primary patellofemoral pain as a consequence of increased neural growth factor generation, which is certainly not without impact on knee joint function. Changes in both the histological structure (presence of inflammation and microcalcifications) and the extent of innervation of the tensor fascia lata (nerve fibers atrophy) being observed in patients with chronic lumbago, may explain the impaired stability and proprioception at the knee joint.

Research in recent years has shown that fascia plays a significant role in muscle force transmission wound healing, skin vascularization, and tropism Impaired muscle mechanical coordination, proprioception, balance, the occurrence of myofascial pain, and spasms are most commonly associated with dysfunctions of the deep fascia and the epimysium. Changes in the mechanical properties of the fascia may reduce muscle extensibility, generating a disturbance in joint range of motion (ROM). It is likely that a reduction in the extensibility, or flexibility of the fascial network results in impaired neuromuscular control and fiber recruitment patterns of these muscles .

Alteration of muscle fiber recruitment patterns can lead to changes in the forces transmitted to the connective tissue, which in turn can lead to remodeling of the structure of other connective tissue such as ligaments and the joint capsule . Over time, changing movement patterns can increase the amount of connective tissue adhesions, leading to reduced mobility, especially in the presence of inflammation and pain. The fascia is also involved in the process of interoception and proprioception. The process by which the body senses, interprets, integrates and regulates signals coming from within, including from deeper layers of connective tissue, in the context of structural damage to the knee joint, appears to be particularly important . Proprioception is dependent on the functioning of rapidly-adapting specialized mechanoreceptors, which are located in joint capsules and tendons. Analyzing the structure of the fascia, the retinaculum is the most innervated part, rich in free nerve endings, Ruffini’s, Pacini’s, Golgi-Mazzoni’s and less numerous spherical clubs. The retinaculum therefore act as specialized proprioceptive organs.

Manual therapy (MT) protects soft tissues against fibrosis induced by overload, supports post-trauma (surgery) recovery processes, influences the stimulation of satellite cell proliferation following muscle fiber damage, guarantees the correct course of the inflammatory process, while at the core of its action lies the possibility of modelling the composition of the HA-rich matrix . The term “soft tissue therapy” (STT) includes mechanical treatment methods involving passive kneading, pressing and stretching (manual stretching) of pathologically tense tissues with the help of a physiotherapist’s hands (hands-on technique) or an instrument (instrument-assisted soft tissue mobilization, IASTM). Popular methods used in STT include trigger point therapy, muscle energy technique, skin rolling, and massage therapy. Methods allowing modelling of the fascia structure seem to be particularly important in STT. The myofascial restrictions and perceived lack of glide between the layers of fascia can be reduced through fascial manipulation (FM), myofascial release (MFR), the Graston technique containing IASTM, or deep tissue massage .

Among the joints of the lower limb, the knee joint is the most exposed to pathological loads generated as a result of joint restrictions or structural disorders of the musculo-fascial bands . Research shows that ROM restriction at both the hip and ankle has a significant impact on the risk of injury and degenerative changes in the knee joint . The balance of tension within the kinematic chain appears to be important in both the prevention of injury, disease, and the treatment of knee joint dysfunctions or postoperative conditions. Knee osteoarthritis (KO), ligamentous and meniscus damage are among the most common pathologieswhich have a significant impact not only on the biomechanics of the knee joint itself, but of the entire motor system. In the case of structural disorders of the knee joint, a decrease in ROM, muscle strength, and gait speed is observed, as well as an increase in the load transferred through the joint . Common surgical treatments for the knee, such as total knee replacement (TKA) or ligament reconstruction, aim to improve the function of the lower limb. (233-234)

**Therapeutic massage**

Therapeutic massage is the manipulation of the soft tissue of whole body areas to bring about generalized improvements in health, such as relaxation or improved sleep, or specific physical benefits, such as relief of muscular aches and pains. Vigorous massage can bring about healing by improving the circulation of the blood and lymph. Complementary therapists have adapted Swedish massage to place greater emphasis on the psychological and spiritual aspects of treatment. Benefits of massage are described more in terms such as “calmness” or “wholeness” than in terms of loosening stiff joints or improving blood flow. Current massage techniques are more gentle, calming, flowing, and intuitive. In reflexology, areas of the foot are believed to correspond to the organs or structures of the body.

Damage or disease in an organ is reflected in the corresponding region, or “reflex zone,” of the foot. Palpation of this zone elicits pain or a pricking sensation, no matter how gently pressure is applied. Reflexology treatment consists of massage of the disordered reflex zones.

| ***Techniques used in massage*** |
| --- |
| *Effleurage*—Gentle stroking along the length of a muscle |
| *Petrissage*—Prèssure applied across the width of a muscle |
| *Friction*—Deep massage applied by circular motions of the thumbs or fingertips |
| *Kneading*—Squeezing across the width of a muscle |
| *Tapotement*—Light slaps or karate chops |

Practitioners generally treat the whole body, using oil or lotion to help their hands move over the patient's body. A variety of strokes are used, including effleurage, petrissage, kneading, and friction. Massage practitioners who treat sports injuries and musculoskeletal disorders may incorporate techniques derived from physiotherapy, osteopathy, and chiropractic, including deep massage, passive and active stretching, and muscle energy techniques (in which the patient moves against resistance from the practitioner). Patients usually find massage deeply relaxing and pleasurable. Some techniques include strong pressure, which can cause painful sensations, but these are usually short lived. Primary uses of massage described in terms of “relief from stress” are to promote relaxation, treat painful muscular conditions, and reduce anxiety. Practitioners claim massage leads to short-term improvements in sleep disorders and pain, conditions known to be exacerbated by anxiety.

Massage practitioners and their patients claim that massage improves self-image in individuals with physical disabilities and terminal illnesses. Touch itself is likely to be therapeutic, particularly for patients with limited opportunities for physical contact, such as those without intimate friends or family or with painful physical conditions. Massage is also said to help patients feel cared for. Patients may be more ready to face and discuss difficult psychological issues when they are less anxious, feel better about themselves, and trust their care providers. This sense of caring leads to better communication and is one of the reasons why massage can be an important stepping stone to effective counseling, such as when managing mental health problems or addiction.

Other settings in which massage is used to foster communication and relationships including work with children with profound disabilities, where touch may be a primary means of communication. Similarly, some midwives run “baby massage” groups in which new mothers learn massage as a way to improve their relationship with their children. Practitioners of reflexology claim that, in addition to the relaxation and nonspecific effects of massage, they can bring about more specific changes in health including case histories of ataxia, osteoarthritis, and epilepsy or conditions as diverse as infertility, acne, diabetes, and hay fever.Most of the clinical trials of massage have focused on psychological outcomes of treatment. Good evidence from randomized controlled trials supports the more traditional effects of massage, such as improved circulation and decreased muscle tension and indicates that massage reduces anxiety scores in the short term in settings as varied as intensive care, psychiatric institutions, hospices, and occupational health and benefits such as relief of musculoskeletal pain, increased mobility, or improved athletic performance.

Evidence from randomized controlled trials shows that massage in premature infants is associated with objective outcomes such as more rapid weight gain and development. Contraindications to massage are based largely on common sense for example, avoiding friction on burns or massage in a limb with deep vein thrombosis. Studies have shown that gentle massage is only a moderate physiologic stimulus that does not cause undue strain on the heart.



Fig.29. A typical massage treatment session.



**Fig.30. Baby massage is one way of encouraging physical interaction and stimulating the developing relationship between parent and child. (235)**

**Deep tissue massage (DTM)**

Definitions of deep massage and deep tissue massage should be used to describe the intention of the therapist to treat deep tissue by using any form of massage and deep tissue massage should be used to describe a specific and independent method of massage therapy, utilizing the specific set of principles and techniques as defined "The understanding of the layers of the body, and the ability to work with tissue in these layers to relax, lengthen, and release holding patterns in the most effective and energy efficient way possible within the parameters of comfort". Favorable outcomes may result from deep tissue massage in pain populations and patients with decreased range of motion. Today there are many methods and types of massage. The Australian Association of Massage Therapists lists over 60 methods. (236-237)

**Yoni Mapping Therapy**

Taken from the Sanskrit for *vagina,*the definition of the word *yoni* encompasses the entire life-giving reproductive system. Yoni Mapping Therapy is a blend of talk therapy and external and internal massage that aims to release mental and physical tension and heal old wounds that are preventing vagina owners from living their best lives and discovering their personal truths. This intimate massage modality that considers the entire spectrum of mental and physical sexual health to address inconsistencies in the field of intimate touch therapy. Yoni mapping therapist spends at least the first hour in conversation, letting talk through the lived sexual experiences and thoughtful questions that can lead to self-discovery and healing.

The point of this specific therapy session isn’t physical arousal. Many women may laugh or cry as their bodies reacted to sensitivities or release muscle tension, while others may describe something akin to a climax that resonates throughout their entire body. The massage portion of Yoni Mapping Therapy is actually just that – a massage, albeit obviously one in a very personal space.

There *is*a chance to discover the location of G-spot, as practitioners should be highly skilled in teaching women about their anatomy toreach a climax when they feel ready or at least experience emotional and physical healing by holding tension in the pelvic region from everything from uncomfortable or traumatic sexual experiences to the often numbing environment of visiting a gynecologist, which dampens our ability to feel pleasure. Internal Yoni Massage finds and releases the source of sexual setbacks and unhealthy habits that hide in muscle knots and tightness.

Different from traditional external massage, the actual internal mapping creates a framework for what physical areas need attention (in the abdominal or pelvic area). Practitioners keep the conversation flowing as they essentially get women fully acquainted with their own vaginas and change their pelvic floor health and body image into a positive one. The majority of the world’s Yoni Mapping therapists reside in Australia, Scandinavia and the United States.

Many gynecological and sexological problems (like urine incontinence, chronic pelvic pains, vulvodynia, and lack of lust, excitement, and orgasm) are resistant to standard medical treatment. Vaginal acupressure, or Hippocratic pelvic massage, can help some of these problems. Technically, it is a very simple procedure as it corresponds to the explorative phase of the standard pelvic examination, to provoke the processing and integration of feelings, but sometimes it can be very difficult to control the emotions released by the technique, i.e., regression to earlier traumas from childhood sexual abuse.

Vaginal acupressure helps the patient to become present in her pelvis and to integrate old traumas with painful emotions. Holistic gynecology and sexology can help the patient to identify and let go of negative feelings, beliefs, and attitudes related to sex, gender, sexual organs, and body. Shame, guilt, helplessness, fear, disgust, anxiety, anger, hatred, and other strong feelings are almost always an important part of a sexual or functional problem as these feelings are “held” by the tissue of the pelvis and sexual organs. Acupressure through the vagina/pelvic massage must be done with great care by an experienced physician, with a third person present, after obtaining consent and the necessary trust of the patient. It must be followed by conversational therapy and further holistic existential processing.

Sexology is the medical specialty concerned with sexual dysfunctions. The most profound theory for sexuality seems to be the theory of the anima and animus (the inner man or woman) of Carl Gustav Jung (1875–1961). Holistic sexology aims to take the established knowledge on sexology into an existential perspective, including the sphere of existential dimensions and problems in the treatment of sexual and gynecological problems. The sexual and gynecological problems are symptoms of unsolved existential problems, where the patient’s inner potentials for healing his/her own life, body, and existence are not mobilized. The negative emotions of the hidden and severe traumas from violence or sexual abuse in the past, are held by the pelvic tissues and organs.

An incidence of about 15% of girls from different western countries being assaulted sexually in childhood are likely to demonstrate severe pelvic problems in their youth. Sexual and gynecological problems resistant to standard therapy are typically problems with acceptance of own sex and sexuality, which do not have to originate from abuse, but can be a result of not having received particularly from the father the loving acceptance and contact touch needed in childhood as an important part of her infantile and undeveloped.

Hippocrates, (460–377 BCE) , aware of such diseases and their treatment included different physical procedures focused on the female pelvis, like smoking the vagina and massaging the pelvis. In holistic medicine, the physician and his/her patient are almost always very close and ethics are a subject of utmost importance. The ability to the The practice of pelvic massage at the essence of medical ethics might have been the very reason why Hippocrates invented his strict medical ethics in the first place

The life mission theory, is based on the philosophy that everyone has a purpose, that leads to happiness expressing the core talent in life. It is important to develop as a person into what is known as the natural condition or a condition where the person knows himself /herself and uses all his/her efforts to achieve what is most important for him/her.

The theory of talent states three major talents in life called purpose, consciousness, and gender and three dimensions be love, power, and sex. Gender and sexuality are fundamental dimensions of human existence, which must be in a sound, natural, and undenied state for the person to live and function naturally and in full power. The holistic process theory of healing and the related theories for salutogenesis, found that the return to the natural state of being is possible whenever the person gets the resources needed for existential healing , which are holding in the dimensions of awareness, respect, care, acknowledgment, and acceptance with support and processing in the dimensions of feeling, understanding, and letting go of negative attitudes and beliefs according to the meaning and quality of life. The preconditions for holistic healing to take place are trust and the intention.

Existential healing is not a local healing of any tissue, but a healing of the wholeness of the person, making him/her much more resourceful, loving, and aware of himself/herself, his/her own needs, and wishes in letting go the negative attitudes and beliefs. The person returns to a more responsible existential position with an improved quality of life. The philosophical change taking place when the person is healing is often a change towards preferring difficult problems and challenges, instead of avoiding difficulties in life . The person who becomes happier and more resourceful becomes more healthy, more talented, and more able to function

Sexual problems are found in four major forms: lack of libido and arousal and potency, pain and discomfort during intercourse, and lack of orgasm. It is possible to work with a holistic approach to sexology in the clinic in order to find and repair the negative beliefs, repressions of love, and lack of purpose of life, which seemingly are the core to problems like arousal, potency, and pain with repression of gender and sexuality.

The theory of talent seems to be relevant for understanding human sexuality. It is highly important not to focus on the gender and genitals but also without neglecting the body and the feelings not connected to it in order to understand the patient’s sexual problems, because many problems related to sex can be solved on the level of the whole person. Shame, guilt, helplessness, fear, and other strong feelings are alwaysb an important part of a sexual problem.

Many women have problems related to their pelvis , dominated by sufferings of the sexual organs, problems of the urinary tract, the locomotor system, and the intestines, or “nonanatomic” pelvic pains and discomforts of psychosomatic nature, difficult to treat with biomedicine, but react better to psychosomatic treatments.

New treatment tools are needed for this broad range of problems, from urine incontinence, bleeding, and hormonal disturbances; unwanted childlessness; sexual problems like pain during intercourse; primary vulvodynia; or low ability to feel lust, pleasure, sexual excitement and/or to reach sexual climax; to non-inflammatory perineal and anal pains and discomforts like idiopathic aches (primary pruritus). From a holistic medical perspective, the problems are caused by unsolved emotional problems that have been repressed into the pelvis and its organs.

The emotional problems that are related to negative beliefs about self, gender, body, organs, and sexuality , can be solved with holistic sexology (acceptance through touch and, when necessary, vaginal acupressure), through healing the old wounds of the body and soul in holistic existential gynecological, and sexological therapy. Healing process has three obligatory steps : feel, understand, and let go. First the emotions have to be felt again; this phase is called “putting feelings onto the body”. Then the patient has to find words, i.e., verbalize the emotions and understand where the problems are coming from; this phase is called “putting words on the feelings”. The person healing has to let go of the negative attitudes and decisions that were made when the trauma happened; this stage is called “putting consciousness in the words . Acupressure through the vagina always builds on earlier sessions of acceptance through touch, which again come after sessions of emotional healing, trust, and holding, and always begin with “love and care” for the patient

Knowledge of healing life (improving health, quality of life, and ability in one integrated movement) known as Corpus Hippocraticum was described on the island of Cos, the cradle of medical sciences around 300 BCE, by Hippocrates (460–377 BCE), considered the best physician of his time and father of the first scientific system of holistic healing. Massaging the pelvis through its openings was an acknowledged method in use throughout Europe for centuries. This necessitated very stringent medical ethics practice that was founded by Hippocrates with the purpose so that he himself and his many pupils could give this kind of treatment.

Massage of the pelvic structures of a woman through the vagina and anus could, among other things, heal disturbances in the woman’s energy system known as a disease called “hysteria” from the Greek word for uterus, hystera. Treatment was in use in most of the western world until the industrial revolution, where it was condemned as pornographic and no longer an acceptable medical treatment. After the sexual revolution in the 1960s and 1970s, there has been more relaxed attitude towards the body and sexuality, and some therapists has started to work again with this kind of therapy through the vagina and anus either by using their hand to cure sexual and other problems, or by using a vibrant penis substitute (a “dildo”) to cure incontinence or orgasmic problems.

The rationale for the use of the vibrator is that the woman cannot get in contact with their own pelvis, as they “cannot find their pelvic floor”, because they have completely eradicated some of the pelvic structures from their inner description of their own body. There are several different forms of pelvic massage/vaginal acupressure used for different purposes with as many philosophies about its mechanisms. Therapists intend to raise the energies in the meridians found in the Chinese system, hence the name “vaginal acupressure” for the technique, used for healing chronic pains in the pelvis or genitals, and treating the highly inconvenient pattern of frequent reinfection of the urinary system. Other therapists intentionally liberate the sexual energies with sexual stimulation, according to the old Indian Tantric tradition, in order to teach the woman to contain and handle her sexual energies. The physician, under no circumstances, should not attempt to stimulate the woman to an orgasm in order to avoid a sexual situation. Traumas of incest and rape can be healed with confrontational therapy by integrating the bioenergetic system, Reich’s sexual therapy, and the gestalt therapeutic tradition to be able to release all negative emotions and other problems caused by the prior sexual violation or neglect and help the patient notice the tensions and blockages in the pelvic region, and the parallel attitudes fragmentizing the patient’s life. When the patients confront and integrate the repressed painful feelings that created them, they develop a new and more positive understanding of life, love, feelings, and sexuality. The elements of acupressure through the vagina must be adjusted to the needs of the patient. A patient with chronic bladder infection and a patient with chronic pain in the pelvis or the sexual organs (primary vulvodynia) should be treated differentlyis.

It is important to always go for the lesser level of treatment that can solve the problem and the least provocative or painful of methods must be tried before more “embarrassing” methods such as emotionally challenging procedure of acupressure through the vagina is taken into use— except in the cases where the patient does not want for personal, political, religious, or other reasons. The physician should always tell the patient about the alternative treatments to be equally efficient and respect the patient’s choice.

If a sexual problem can be solved with just giving acceptance to the body, there is no reason to approach the sexual organs. If just giving acceptance to the outside of the vulva is enough to solve the problem, there is no rationale for penetrating the vagina. Often the feelings of guilt and shame that are the cause of the problem can be solved by the smaller process called “acceptance through touch” and, in this case, it would be unethical to start with acupressure though the vagina. If conversational therapy can do the job, touching the vulva will be unethical .

Vaginal acupressure is technically the most simple procedure as it corresponds to the explorative phase of the classic pelvic examination, except that the purpose of the digital penetration is treatment and not examination. Vaginal acupressure is performed by placing the woman on the examining table in a relaxed position with free passage to the vagina . The physician penetrates the vagina with one or two fingers and presses systematically on the sore and tense areas in the pelvis. The position of the physician’s hand must be so that only the structures that need to be touched are contacted (it is important that the clitoris is not touched unintentionally). The applied pressure is adjusted to the situation to optimize the therapeutic effect.

Acupressure through the vagina must be performed according to ethical standards. The holistic sexological procedures are derived from holistic existential therapy (which involves reparenting, massage and bodywork), conversational therapy, philosophical training, healing of existence during spontaneous regression to painful life events (gestalts), and close intimacy without any sexual involvement.

Since Hippocrates, the fundamental rule has been that the physician must control his/her behavior, not to abuse the patient. The patients in holistic existential therapy and holistic sexology are chronically ill and their situation could seem hopeless, since they might have been dysfunctional and incurable for many years or they are suffering from conditions for which there are no efficient biomedical cures. The primary purpose of holistic existential therapy is to improve quality of life; secondary, to improve health and ability. The severe conditions of the patients and the chronicity is what ethically justify the much more direct, intimate, and intense method of holistic existential therapy, which integrates many different therapeutic elements and works on many levels of the patient’s existence and personality at the same time.

Holistic. sexology is holistic existential therapy taken into the domain of sexology. The general ethical rule is that everything that does not harm and will help the patient in the end is allowed (“first do no harm. To perform the sexological technique of acupressure through the vagina, the holistic sexologist must be able to control not only his/her behavior, but also his/her sexual excitement to avoid any danger of the therapeutic session turning into sexual activity. Most physicians can do the classic pelvic examination after their standard university training, but the vaginal acupressure can only be obtained through long training and supervision in order to reach a level where such a procedure can be performed. Side effects of the treatment can be soreness of the genitals and periods of bad mood as old painful repressed material are slowly integrated.

In an acute psychosis as a sexually abused woman could confront her most painful experiences, but she can recover in a few days without the use of drugs and this episode is an integral part of her healing . As it is possible that the patient can feel abused from transferences, it is extremely important to address this openly to prevent this situation and contact the patient is and follow up for 1–5 years to handle any potential long-term negative effect of the treatment. During the therapy it is of utmost importance that the physician and the patient remain in contact at all times, the physician must look the patient in the eyes in a relaxed way to ensure the patient that everything is going as it should. Balance and contact are the keywords for smooth and trouble-free therapy. If the patient gets into emotional pains, this must be taken care of right away. If the patient unintentionally gets sexually exited, the physician must be trained to contain that without getting into sexual excitement him or herself. The physician must be trained to be able to control his/her own sexuality to such a degree that the healing of the patient is the sole focus of the physician’s intention, and acupressure through the vagina must always be done under proper supervision. The effect of the therapy must always be measured with a quality of life and health questionnaire like QOL1 and QOL5 administrated to the patient before, after, and years after the therapy so that the physician can be sure that he/she actually helps the patient, now and in the long term. It is easy to believe that the patient has been helped immediately after the completion of the therapy, but what is important is that if the patient finds that the therapy has been helpful even years after it has ended. After each session, what has happened must be thoroughly discussed with the patient, and the patient-physician relationship must be cleared whenever there is a retraction or an emotional issue in the relationship

In holistic sexology work with patients, the physician must always be present as a human being. The physician doing this kind of work may have qualms and concerns, but still and must be extremely cautious and conscientious when breaking one of the toughest taboos in the medical world, namely sex. It is severely frowned on to touch the most private part of the body, the pelvis and its organs, female private parts if it is not in connection with a pelvic examination , but confronting the emotions contained there.

Pelvic massage, or acupressure through the vagina, is a bodywork technique. It seems to have been used by physicians ever since Hippocrates. It has been condemned as pornographic for a century, but it still seems to be very much needed to cure chronic patients suffering from a wide range of problems resistant to standard treatment and related to the structures of the pelvis: urine incontinence, tensions and chronic pains, a wide range of sexual problems. The rationale behind acupressure though the vagina is that this procedure can help the patient to confront old painful emotions held by the local tissue and to identify and let go of negative beliefs and decisions from the traumatic life events. This procedure is a way to free the patients and their pelvis from the repressed feelings, love, and purpose of life. When the patients feel their repressed emotions, understand their message, and let go of the negative beliefs that have repressed them, they will heal their whole existence, including the body, its organs, energy, and sexuality at large.

Ethical aspects in holistic sexology are of extreme importance. As long as the physician loves and cares for his/her patient, gets his/her trust , gives holding flawlessly, and as long as ensures that the patient is in full control and not in any way violated, such a treatment can never be unethical. The physician must certainly follow the ethical rules of the country where the practice is performed and many countries have legal restrictions to such a holistic practice.

It is important to understand that this contact is not and shall not be a sexual contact. The most important qualification of the physician trained in the bodyworks of holistic medicine is his/her ability to control his/her own intention and level of sexual excitement to ensure that this contact never turns into a sexual contact. (238-239)

**Theory of Mind (ToM), Yoni task**

Theory of Mind (ToM), a high-order human social cognition skill, is relevant for mental health and wellbeing and frequently impaired in many clinical conditions. To detect ToM difficulties, validated and standardized measures need to be adopted in clinical practice. The Yoni task provides a comprehensive evaluation of first-order, second-order, affective and cognitive mentalistic inferences. Social cognition refers to any process involved in the detection, elaboration, and interpretation of social information, that is, the ability to represent other's intentions, emotions, desires and beliefs, and appropriately respond to them.

These capabilities are crucial for successful communication and social interaction, with signiﬁcant implications in mental health, wellbeing, and quality of life in both typical and atypical development. Social cognitive impairments are among the earliest and predominant clinical symptoms of many acute and chronic neuro-cognitive disorders. The relevance of social cognitive functioning assessment has been formally notiﬁed in the ﬁfth edition of the

Diagnostic and Statistical Manual of Mental Disorders, where social cognition is included as one of the six cores of neurocognitive domains.

Diﬀerently from the ﬁve traditional neurocognitive domains (learning and memory, executive function, complex attention, perceptual-motor function, and language), grounded on a long history of validation of neuropsychological assessment tools, studies on psychometric characteristics, and normative data of social cognition tests are relatively few especially for high-order social cognition abilities, such as Theory of Mind (ToM) or mentalizing, the ability to think to one’s own, and others’ mental states to comprehend and predict their behaviours. The nature of this capability is complex and multi-component, embracing an aﬀective and a cognitive component, referring respectively to emotions and intentions driving behaviour. T

The meta-representation of mental states presents diﬀerent levels of attribution, such as the ﬁrst- and second-order inference which has been classically investigated with ﬁrst and second-order false belief tasks.Although a substantial number of ToM tools are presented in the literature, most of them do not assess all these components of mentalizing. For example, the already mentioned False Belief task evaluates only the recursive level of mentalizing, without considering separately cognitive and aﬀective components.

The Faux Pas Recognition test , assess both the aﬀective and cognitive components without taking account recursive thinking (e.g., ﬁrst and second order beliefs). Even the more ecological measures of ToM, based on multimedia stimuli, as the Toward the Assessment of Social Cognition test and the Movie for the Assessment of Social Cognition focus only on cognitive and aﬀective ToM aspects, and not on the level of recursive inference.

The Faux Pas test nor the Story-based Empathy task have been validated. To date, the ToM test validated and mostly adapted for different languages and age groups remains a measure of aﬀective mentalizing, the Eyes Test. Among the available ToM measures, the Yoni task is currently used as a complete computerized ToM measure to evaluate ﬁrst and second-order, aﬀective and cognitive mental state attributions. The Yoni task has been proved to be valuable in the research context. Diﬀerent versions of the Yoni task have been applied in many clinical conditions: the 64-item version has been used to investigate cognitive and aﬀective ToM in patients with localized brain lesions, schizophrenia, and criminal oﬀenders a 60-item version as a measure of mentalizing ability in patients with Parkinson Disease and healthy subjects. In the Italian context, ToM abilities have been assessed with the translation of the Yoni task, in its 98-item version, in subjects with Mild Cognitive Impairment and Parkinson’s disease.

Considering the beneﬁts of the Yoni task compared to other social cognitive tests, the Yoni task presents many advantages. Firstly, diﬀerently from the majority of social cognition tools, it allows a global comprehensive assessment of ToM, evaluating both cognitive and aﬀective mental states,

and also ﬁrst and second-order beliefs. Also, Yoni presents simple visual stimuli with an ease of presentation modality purposively designed to minimize the inﬂuence of language, memory, and executive function on the subject’s performance. This aspect is crucial considering that other social cognition measures have been reported to be inﬂuenced by the level in other neurocognitive domains. Divergently from story-based tests such as the Strange Stories, requiring a contextual interpretation of interactions, the simple stimuli of Yoni allow excluding the eﬀect of social norms and autobiographical memory on the test score. To include the Yoni task into neuropsychological screening, the existing versions of the tool are not agile in their current form for the huge

time-related demand.

According to these premises, exploring the convergent and discriminant validity, and inter-item reliability of the Italian version of the Yoni task score and providing normative data for the 98-item version in the Italian population and developing two short versions of the Yoni task from the 98-items version balanced for its subdomains (ﬁrst- and second-order, aﬀective and cognitive components),Yoni may constitute a useful ToM measure to investigate neurocognitive impairment in atypical conditions in line with the neuropsychological and neuro-science evidence demonstrating the co-existence of aﬀective and cognitive ToM, with related separate brain networks and neurochemical systems as well as proposing new indexes such as the CAA and CA index. (240).

**Tantra,**

Tantra Sanskrit: त, meaning to weave, warp' are the esoteric traditions of Hinduism and Buddhism that developed in India from the middle of the 1st millennium CE onwards. The term tantra, in the Indian traditions, also means any systematic broadly applicable "text, theory, system, method, instrument, technique or practice." Tantric yoga comprises a philosophical sphere including body and mind and does not limit itself to sexual perspective Tantra had its origin in India itself and then had spread to other parts of the World. Tantra is amalgamated with aspects like sex, magic and sacrifice. Yoga, the ancient practice of meditation and wisdom comprises one of the vestigial practice that is followed in Tantra. Yoga and Tantra both contributed each other in its enhancement.Yoga comprises a distinct and well established school in Indian philosophical thought but in union with Tantra, it is identified as Tantric Yoga. Sitting in a Yoga posture performing a tantric ritual is the oldest evidence known of Tantric Yoga, the Royal path of sexual yoga. Eventhough Yoga has invariably been allied with religious traditions like Hinduism, Buddhism and Tantra, it constantly maintained its innate feature.

'union' could mean the actual act of sexual intercourse, ritual uniting of concepts through chanting and sacrifice, or realization of one's true self in the cosmic joining of the divine principles of Shiva and Shakti in Para Shiva. Tantrism, which appears in both Buddhism and Hinduism, influenced many religious trends and movements from the 5th century CE. Tantrism bases itself upon mystic speculations concerning divine creative energy (shakti).

Tantrism is thought to be a method of conquering transcendent powers and realizing oneness with the highest principle by Yogic and ritual means—in part magical and orgiastic. Tantrists take for granted that all factors in the macrocosm and the microcosm are closely connected. The adept ( sadhaka) has to perform the relevant rites on his/her own body, transforming its normal, chaotic state into a “cosmos.”

The macrocosm is conceived as a complex system of powers that by means of ritual-psychological techniques can be activated and organized within the individual body of the adept. The Tantrists emphasize the activation and sublimation of the possibilities of their own body, without which salvation is believed to be beyond reach.

The Tantrists of the Vamchara (“the left-hand practice”) sought to intensify their own sense impressions by making enjoyment, or sensuality ( bhoga), their principal concern: the adept pursued his/her spiritual objective through his natural functions and inclinations, which were sublimated and then gratified in rituals in order to disintegrate his/her normal personality. This implies that cultic life was largely interiorized and that the whole world was given a new and esoteric meaning.

Tantrikas see the body as a microcosm. In the Kaulajnana-nirnaya, the practitioner meditates on the head as the moon, the heart as the sun and the genitals as fire. The body contains a series of energy centers (chakra - "wheel"), which may be associated with elements, planets or occult powers (siddhi). Kundalini is the flow of the central sushumna nadi, a spiritual current, that, opens chakras. As in all of Hindu and Buddhist yogas, mantras play an important part in Tantra for focusing the mind, through the conduit of specific Hindu gods like Shiva, Ma Kali (mother Kali, another form of Shakti) and even Ganesh, the elephant-headed god of wisdom (refer to the Ganesha Upanishad).

Tantra, being a development of early Hindu-Vedic thought embraced the Hindu gods and goddesses, especially Shiva and Shakti, whom are worshipped externally (with flowers, incense etc.) and used as objects of meditation, where the practitioner imagines him- or herself to be experiencing the darshan or 'vision' of the deity in question. The ancient devadasi tradition of sacred temple-dance, seen in the contemporary Bharata Natyam is an example of such meditation in movement. The divine love is expressed in Sringara and Bhakti. The act of breaking taboos is the definitive feature of left-hand Tantra. All tantras state that there are specific levels of preparation required for breaking taboos. The normal state of human preparation is referred to as pasu-bhava (animal disposition). A person in the state of pasu-bhava is one who regularly eats meat and indulges in intoxication. They areconsidered dishonest, promiscuous, greedy and violent.

A fundamental requirement of all tantras is the initial transcendence beyond this base state. Tantras prescribe a strict regimen of penance, meditation, sensory control, cleansing the self of negative thoughts and seeking truth and justice before an individual can hope to transcend from her or his natural state. An individual who successfully practices these tasks may eventually take a vow of viravrata (a hero's vow) to be of vira-bhava (heroic disposition). The demarcation vira is potentially transient as it is considered a state of being free of desires.

In the Kaula and Vamachara schools of tantra the pañca makara (5 M's) ritually/sacramentally broken in order to free the practitioner from binding In place of the traditional five elements (tattvas) of the Hindu cosmos elements that make human body:

Prithvi (Sanskrit: पृथ्वी:, Earth), Jala (Sanskrit: आपः, Water), Agni (Sanskrit: अग्नि, Fire), Vayu (Sanskrit: वायु:, Air), Akasha (Sanskrit: आकाश, Aether),

in Ayurveda and Indian philosophy, the left-hand Tantrists used the five m’s:

Frost bring forward the earliest evidence of tantric yoga, “In Pakistan, on the Indus River in the ancient city of

 madya (fermented grapes,wine)

 mamsa (flesh,meat)

 matsya (fish)

 mudra ( frumentum, cereal, parched grain, or gestures)

 maithuna ( sexual union made particularly antinomian through the involvement of forbidden women—such as the wife of another man or a low-caste woman—who was identified with the Goddess)

Menstrual blood, strictly taboo in conventional Hinduism, was also used in Tantric rites. Shakta adepts are trained to direct all their energies toward the conquest of the Eternal. The sexual act and the consumption of consecrated meat or liquor are esoterically significant means of realizing the unity of flesh and spirit, of the human and the divine. They are considered not sinful acts but effective means of salvation. Ritual union—which may also be accomplished symbolically—is, for both partners, a form of sacralization, the act being a participation in cosmic and divine processes. The experience of transcending space and time, of surpassing the phenomenal duality of spirit and matter, of recovering the primeval unity, the realization of the identity of God and his Shakti, and the manifested and unmanifested aspects of the All, constitute the very mystery of Shaktism.

Tantrists describe states of consciousness with erotic terminology and describe physiological processes with cosmological terminology. They proceed from “external” to “internal” worship and adore the Goddess mentally, offering their hearts as her throne and their self-renunciation as “flowers.” According to Tantrism, concentration is intended to evoke an internal image of the deity and to resuscitate the powers inherent in it so that the symbol changes into mental experience. This “symbolic ambiguity” is in evidence in the esoteric interpretation of ritual acts performed in connection with images, flowers, and other cult objects and intended to bring about a transfiguration in the mind of the adept.

The mantras (sacred utterances, such as hum, hrim, and kleem) are believed to be indispensable means of entering into contact with the power they bear and of transcending mundane existence. Most potent are the monosyllabic, bija (“seed”) mantras, which constitute the main element of longer formulas and embody the essence of divine power as the eternal, indestructible prototypes from which anything phenomenal derives its existence.

The cosmos itself owes its very structure and harmony to them. The introduction of spiritual qualities or divine power into the body (nyasa) by placing a finger on the relevant spot (accompanied by a mantra).Tantrists who follow the “right-hand path” attach much value to the Yoga that developed under their influence and to bhakti and aspire to union with the Supreme by emotional- dynamic means. For them, Yoga is a self-abnegation in order to reach a state of ecstatic blissfulness in which the passive soul is lifted up by divine grace.

There is a Tantric mantra-yoga (discipline through spells), which operates with formulas, and a hatha- yoga, (Sanskrit: “union of force”) that incorporates normal Yogic practices such as abstinences; observances; bodily postures; breath control; withdrawal of the mind from external objects; concentration, contemplation, and identification with the aid of mudras (i.e., ritual intertwining of fingers or gestures expressing the metaphysical aspect of the ceremonies or the transformation effected by the mantras); and muscular contractions. It also consists of internal purifications (e.g., washing out stomach and bowels), shaking the abdomen, and some forms of self-torture. The whole process is intended to “control the ‘gross body’ in order to free the ‘subtle body.’”

Some Tantrists employ laya-yoga (“reintegration by mergence”), in which the female nature- energy (representing the shakti), which is said to remain dormant and coiled in the form of a serpent (kundalini) representing the uncreated, is awakened and made to rise through the six centres (chakras) of the body, which are located along the central artery of the subtle body, from the root centre to the lotus of a thousand petals at the top of the head, where it merges into the Purusha, the male Supreme Being. Once the union of shakti and Purusha has become permanent, according to this doctrine, wonderful visions and powers come to the adept, who then is emancipated.

The Tantric texts pursue worldly objectives involving magic or medicine. Shakti is the deciding factor in the salvation of the individual and in the processes of the universe because God acts only through his energy—which, personified as a goddess, is his spouse. Her role is very different in the various systems: she may be considered the central figure in a philosophically established doctrine, the dynamic aspect of brahman, producing the universe through her maya, or mysterious power of illusion; a capricious demonic ruler of nature in its destructive aspects; a benign mother goddess; or the queen of a celestial court.

The esoteric Vaishnava-Sahajiya cult, which arose in Bengal in the 16th century, was another emotional attempt at reconciling the spirit and the flesh. Disregarding social opinion, its adherents, using the natural (sahaja, “born with”) qualities of the senses and stressing the sexual symbolism of Bengal Vaishnavism and sought for the perpetual experience of divine joy. After arduous training, the realization of love can be experienced, because Krishna’s nature is love and the giving of love. Women, as the embodiment of a theological principle, could even become spiritual guides, conducting the worshipers in their search for realization. After reaching this state, a devotee remains in eternal bliss and can dispense with guru and ritual and be completely indifferent to the world, “steadfast amidst the dance of maya.” In Tantrism the consciousness is spoken of as moving—driven by repetition of the mantra and by other disciplines—from gross awareness of the material world to realization of theultimate unity. The image is of a serpent, coiled and dormant, awakened and driven upward in the body through various stages of enlightenment until it reaches the brain, the highest awareness.

The 19th-century mystic Ramakrishna describes the process :When the serpent is awakened, it passes gradually through various stages, and comes to rest in the heart. Then the mind moves away from the gross physical senses; there is perception, and a great brilliance is seen. Seeing a brilliance, the worshiper, is struck with wonder. The serpent moves through six stages, and coming to the highest one, is united with it. When the serpent rises to the sixth stage, the form of God is seen. But a slight veil remains; it is as if one sees a light within a lantern, and thinks that the light itself can be touched, nothing external remains anymore. One cannot even take care of his/her body any more; if milk is put into his/her mouth, he/she cannot swallow. If he/she remains for twenty-one days in this condition, he/she is dead.

Tantric Hindu traditions have also influenced other Eastern religious traditions such as Jainism, the Tibetan Bön tradition, Daoism, and the Japanese Shintō tradition. Certain modes of non-Vedic worship such as Puja are considered tantric in their conception and rituals. Hindu temple building also generally conforms to the iconography of tantra. Hindu texts describing these topics are called Tantras, Āgamas or Samhitās. Rituals are associated with spiritual or religious activities. A ritual is a ceremony consisting of a series of actions performed by an ordained leader and according to a prescribed order.(Weddings, funerals, birthdays, coming of age rites, mass, baptisms, communion and religious holidays). Essentially they mark important moments and serve as an initiation or a change in status.

Tantric rituals are a spectacular science stemming from the Indian tradition which have been known to produce supernatural phenomenon and provide a direct link to universal energies for participants if the ritual is of the authentic kind. In order to benefit from the imprint tantric rituals, there are certain key elements that are necessary in order to receive this sacred rite of passage. Tantra is the science and study of energy and there are countless different types of energy in the universe that can be controlled and utilized for spiritual gains. For every universal energy that exists there are various tantric rituals that train solely with that energy.Tantric rituals can be extremely potent if the right ingredients are involved and the knowledge is genuine. The secrecy of this occult science preserves its integrity and esoteric nature. There is not any ritual manual, that outlines and details all of the various rituals and accompanying effects. Knowledge is transmitted via a lineage and ideally by an experienced master. (242-243)

**Sexual therapy**

Sexual dysfunctions (SD; e.g., female sexual interest/arousal disorder, erectile disorder, female orgasmic disorder, delayed ejaculation, genito-pelvic pain/penetration disorder, etc.) affect up to a third of individuals, impairing sexuality, intimate relationships, and mental health.Sexual health is fundamental to well-being but has repeatedly been overshadowed in international public health agendas by other concerns like reproductive health and sexually transmitted infections.

The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) defines sexual desire disorder “persistently or recurrently deficient (or absent) sexual fantasies and desire for sexual activity that causes marked distress or interpersonal difficulty” (e.g., male hypoactive sexual desire, erectile, or genito-pelvic pain/penetration disorders, etc.) as a significant impairment of sexual response and pleasure or as pain during intercourse, causing persistent (≥ 6 months) and clinically significant distress. The most prevalent female sexual dysfunction in women is “sexual desire and arousal disorder.

SD impairs sexual and intimate relationships, as well as mental health . About a third of men and women with low sexual functioning report being unsatisfied with their relationships. SD has been found to correlate negatively with sexual satisfaction. Strong bidirectional associations between low sexual functioning and psychological distress were also found. Sexuality is the social behavior of individuals or couples. Religious or social effects change an individual’s response to sexuality. Sexual response is connected to two fundamental physiological changes: the increase in the blood flow of some parts of the body and the increase in muscle tension. Besides, an analysis of female orgasm indicates three key points called physiological, psychological, and sociological. Fear of performance or social pressures reveal themselves as failure to reach orgasm for women and erection problems for men.Sexuality is a multidimensional concept that requires physical and emotional participation. Sexuality and sexual intercourse should not be limited only with the genital system. The genital system forms the majority of sexuality, but as it does not approach the human body as a whole, it is limited only with reproduction. Focusing only on the genital area during sexual intercourse puts skin -the largest erogenous area in the human body- into second place.

Factors that have effects on sexual health include physiological and emotional health, alcohol and substance use, familial relations, sexual abuse experienced in the past, and other traumatic events.Significant decrease or differences in sexual desire and sexual activity can cause disappointment and tension between the couples People who have sexual desire disorder are far from having sexual fantasies and satisfying themselves sexually.Assessment of people who experience a decrease in sexual desire should include several factors such as the couples’ age, hormone features, physical health, and frequency of sexual activity. The person’s psychological strength, limitations, values, and attitudes should be identified. Besides these, one of the factors that affect sexual desire is anxiety. Anxiety prevents pleasure. Another critical factor that affects sexuality is the interaction between couples, which is negatively affected by such factors as anger, lack of communication, and power conflicts. Each spouse’s family features, religious beliefs, cultural differences, attitudes, and values contribute to the sexual life of couples. To solve these kinds of problems, the individual should be approached holistically, and trained about sexual intimacy.

The evaluation of the person with a sexual desire disorder should include the formation of hypotheses about the reasons for the problem. First impressions, personal responses, relationships, and collective lives should be investigated. In the early period of the treatment, aims and couples’ expectations should be identified. Sessions at the clinical assessment phase involve the questioning of sexual fantasies and thoughts, sexual activity and its frequency, and the disturbing . Female sexual dysfunction can be assessed using valid and reliable sexual function scales such as the Female Sexual Function Index (FSFI).

Positive treatment results for people who have sexual desire problem can be maintained under some appropriate conditions, which include the followings:

Couples’ having common sexual desire,

Couples’ having no psychiatric problem,

Elimination of the negative thoughts about sexual desire,

Identification of the factors that cause stress and anxiety,

Ability to discuss with the spouse about the treatable difficulties in their relationship,

Sharing negative religious beliefs

willingness to share negative past experiences.

Anxiety, depression, and bad body image prevent the treatment of sexual desire disorder. Lack of sexual desire is a complicated issue for the individual. Pessimism is a reaction in case of failure. These people should learn to have control over their feelings, behaviors, and sexual satisfaction. Treatment of sexual desire disorder should primarily include individual and relational issues. The treatment aims to bring sexual desire back. The success of the treatment in these kinds of patients is to maintain satisfaction in the relationship. Having sexual problems indicates that what couples wonder and worry about is whether their spouse desires them. Pleasure and desire decrease as anxiety increases. The main purpose of the treatment for lack of sexual desire is to eliminate this anxiety. The definition of sexuality and sex should be expanded, and focusing solely on sexual intercourse should be prevented. Systemic assignments including physical exercises, fantasizing, guided masturbation, review of visual materials, or regular use of sex materials can be given regarding sexual intimacy and fantasies. Assignments for couples may include discussing sexual and emotional needs and exercises for the solution to the problems.

American Urological Association divides sexual arousal disorders as primary, secondary, and situation-specific. Through a detailed taken history, the counselor can identify whether this problem is related to the sexual desire problem, or the decrease in sexual desire developed secondarily. Sexual arousal is a complicated issue to assess. There are limited findings of normal arousal, which is dependent on living conditions, age, and sexual experiences. The physiological response that an individual gives to sexual stimulation is not always at the same level.

Psychological aspects include sexual expectation, anticipatory sexual behaviors, psychic arousal, and sensory extension. Physical aspects of sexual arousal include swelling in vagina entrance, wetness, lubrication, and tingling sensation. Changes in the genital area happen with the increase in the bloodstream in the vaginal and clitoral area. A bloodstream increase in the middle wall of the vagina leads to lubrication. A bloodstream increase in the clitoral area leads to fullness and sensory changes arousal has both psychological and physical aspects. The identification of each aspect separately is essential for the treatment of sexual arousal disorder.

Sexual problems such as sexual arousal disorder deteriorate women’s quality of life and affect their relationships with their partners. While there are cardiovascular, neurologic, and psychological cases accompanied by this case, cancer, and its treatment can also cause sexual arousal disorder. Besides, surgical menopause, which causes a decrease in estrogen hormone, also affects sexual arousal. In addition to these medical cases, cognitive, emotional, and psychodynamic factors cause changes in sexual functions, too. Besides, external genital organs should be examined for genital stimulations by photoplethysmography for the evaluation of the genital stimulus, measurement of labial temperature, Gold Sheffield electrode, and Doppler ultrasonography of clitoral blood flow.

Approach to women’s sexual arousal problem includes five rules:

1. The woman’s and her partner’s views on sexual intercourse are essential because each has a different point of view.
2. The woman’s psychology and psychopathology, which includes her ideas, values, or general notions, should be evaluated.
3. The woman and her partner should be evaluated as a whole in terms of the relationship.
4. The couple’s family and social life should be observed.
5. The effects of social, cultural, and historical factors should be identified in the evaluation phase

**O** **rgasmic Disorders**

DSM-V defines orgasmic disorders as delays in almost every sexual activity, a significant delay in orgasm, lack of orgasm, or low-intensity orgasm. Orgasmic disorder in sexual life can be lifelong or acquired, general or psychological, and caused by situational or both psychological and medical reasons. This dysfunction causes deterioration in interpersonal relationships and stress. The orgasmic disorder might have been caused by misinformation about sex, a decrease in sexual desire, perception of sexual identification, or the effects of medical treatments. Stress, tiredness, general health state, and other personal features also affect sexual desire and response in a negative way. Evaluation of orgasmic disorder in women should include a detailed psychological, social, relational, and medical anamnesis to understand the source of the sexual dysfunction. The woman’s orgasm problem should be investigated in terms of its frequency, whether it is primary or secondary, and how long it has been experienced.

The woman is guided about understanding what stimulates her, which practices give pleasure to her, or which practice is hard or unpleasant during sexual intercourse. In the first phases of the exercises, the woman is suggested to use a mirror to know her genital organs. She is recommended to have sexual fantasies in order to increase her sexual response, feel her senses, and change her negative thoughts about masturbation. Some women could ignore their sexuality and feel guilty during their sexual relationships. Fantasies should aim to improve the woman’s perspective of self as a sexual individual including both emotional and physical aspects of sex, and sexual function should involve the participation of both aspects. Supplementary stimulators might be needed at this stage. Coital intercourse during sexual intercourse is important as it increases orgasm frequency by enhancing clitoris contact.

**Dyspareunia**

DSM-V defines dyspareunia as permanent or recurrent pain during sexual intercourse, which is not related to vaginismus or a decrease in lubrication. Pain during sexual intercourse harms sexual life causing negative changes in female sexual behaviors, harmful behaviors, deterioration in partner relationships, a decrease in self-confidence, and mood disorders. Secondary sexual disorders can also accompany the pain. Women with Dyspareunia state have severe pain during coitus. Besides, they also have pain in penetration cases such as during vaginal tampon or gynecologic examination. Pain during sexual intercourse may develop during menopause due to a decrease in estrogen values so the vaginal elasticity. Pain may be caused by congenital anomalies of the genital system, urinary system infections, and acute or chronic diseases. Episiotomy or other gynecological surgical procedures can cause painful sexual intercourse.

Besides, woman’s negative thoughts, sexual taboos, stress or anxiety, and lack of sexual education also, despite not causing pain alone, are among factors that increase pain. Assessment should be done in terms of the exact location of pain during sexual intercourse, severity and type of pain, whether the pain develops before or after penetration, how long the pain lasts, whether it is continuous or occasional, whether there is pain without sexual stimulus, and the time when the pain is felt during sexual intercourse. The effects of pain on the couple’s sexual life could be administered scales such as FSFI that assesses sexual life . Pain during sexual intercourse may cause couples to be deprived of many experiences. The most important phase of therapy in painful sexual intercourse is training. She should be told that as masturbation increases sexual desire and stimulation, she should masturbate.

The aim in sexual counseling is to decrease the woman’s sexual fears and worries, increase her emotional and sexual response, decrease her anger at her husband, help her experience new emotional and sexual techniques, increase communication between couples, eliminate thoughts that distract attention during sexual intercourse, and decrease her prejudices about having orgasm. Therefore, sexual counseling is a magical key that could be used in solving women’s sexual problems, setting their sexual life free, and increasing their quality of life. Sexual activity (including intercourse, outercourse and masturbation) is a complex experience that involves emotional, mental and physical components. Sexual function is an important contributor to the quality of life. It’s associated with physical and mental well-being and relationship.

Healthcare providers and sex educators break sexual activity down into four phases known as the sexual response cycle:

1. Desire (libido)
2. Arousal (excitement)
3. Orgasm
4. Resolution

Sexual issues can arise at any point during this cycle. Knowing how to respond mentally and physically during each phase can improve the sexual experience . A sex therapist can help with the mental and emotional aspects of various forms of sexual dysfunction, includes:

1. Lack of desire.
2. Lack of arousal
3. Difficulty having an orgasm (anorgasm)
4. Pain during sex (dyspareunia) such as from vaginismus
5. Difficulty getting or keeping an erection (erectile dysfunction)
6. Premature ejaculation
7. Delayed ejaculation

Sex therapists can also help you work through challenges such as:

1. Sex education and correcting miseducation
2. Sexual trauma
3. Feelings of anxiety, fear or shame related to sex
4. Issues around cultural, religious and societal views of sex
5. Improving communication about sex and intimacy between you and your partner(s).
6. Mismatched sexual desire between partners
7. Relationship issues stemming from sexual difficulties.
8. Poor body image and its relation to sex.
9. Coping with and living with sexually transmitetd infections (STI)
10. Hypersexual disorder (sex addiction).
11. Pornography addiction

Sex therapists use psychotherapy (talk therapy) to help people with sexual issues — whether they’re simple or more complex. Sex counselors take more of an action-based approach by offering education and techniques to address short-term problems.Healthy sexual function within one’s expected norm and desire for sexual activity is an important aspect of sexual health. According to the American Sexual Health Association, sexual function is the ability to experience sexual pleasure and satisfaction when desired. It is an important component of quality of life (QoL) as it is associated with physical and mental wellbeing and relationship satisfaction. Sexual function is influenced by a person’s biology (physical and physiological), psychology (feelings and thoughts) and society (interpersonal, cultural, literacy and contextual factors). The importance of sexuality varies between people and fluctuates in individuals’ lives. As sexuality is often viewed as intercourse, there is room to introduce patients to a broader sexuality involving outercourse, masturbation/self-pleasure and sensual touch.

‘Sexual problem’ is an umbrella term to refer to sexual concerns, sexual difficulties, sexual dysfunctions and sexual disorders. A useful distinction between the two most commonly used terms is a time factor, with a sexual difficulty lasting <6 months and a sexual dysfunction lasting >6 months. According to the 2013 Australian Study on Health and Relationships, lack of interest in sex was the single most common sexual difficulty for both men and women. Sexual dysfunctions have many mediating factors including psychological and sociocultural factors, lifestyle factors and health (especially obesity, sleep disorders, anxiety, depression, chronic disease and side effects of medications). Erectile dysfunction can precede cardiovascular symptoms by 2–3 years and cardiovascular events by 3–5 years.

Psychosexual therapy, commonly referred as sex therapy, is a specialty comprised of cognitive-behavioural interventions, mindfulness techniques, systems/couple interventions and psychotherapy. The aim of sex therapy is to help individuals and couples understand, improve and resolve their sexual difficulties involving performance anxieties, arousal and orgasmic difficulties, sexual pain, fear or aversion to sexual behaviour or relationship issues, which can be influenced by family of origin and past and present sexual experiences.

Sex therapy is not a panacea solution for achieving idealised sexual performance. Rather, it aims to restore as much functional capacity as possible, using multifaceted strategies to facilitate satisfying long-term sexuality. Patients are given education, strategies and exercises to do at home. Some of the common issues treated with sex therapy include lack of interest in sex, desire discrepancy between two individuals and the fallout from this difference, erectile dysfunction, painful penetration, vaginismus, past sexual abuse, concerns relating to gender identity and sexual orientation, orgasm difficulties, fear and anxiety about sexual performance and concerns about penis size or specific sexual behaviour.

Patients may have preconceived incorrect ideas about sex therapy, such as believing that sex therapy involves some form of physical/sexual contact with the therapist during the session, which in turn may stop patients from accessing sex therapy. Sexual functioning is a multifaceted process that requires coordinated functioning of many body systems and an adequately healthy state of mind and emotions. Effective, holistic medical care includes addressing sexual health concerns. This has a major role in the QoL of patients and their intimate partners. However, when a sexual problem is addressed in a suboptimal or rushed manner (whether it be during a medical intervention or sex therapy), the impact can be detrimental to the individual/couple. It can result in a relapse of the sexual problem and/or trigger new sexual/non-sexual problems. (244)

**Existential holistic therapy,**

In existential holistic group therapy, the whole person heals in accordance with the holistic process theory and the life mission theory. Existential group psychotherapy addresses the emotional aspect of the human mind related to death, freedom, isolation, and meaninglessness, while existential holistic group therapy addresses the state of the person’s wholeness, that includes the body, the person’s philosophy of life, and love, purpose of life, and the spiritual dimension, to the same extent as it addresses the emotional psyche and sexuality, and much broader than traditional psychotherapy.

Where existential psychotherapy is rather depressing concerning the fundamental human condition, existential holistic therapy conceives life to be basically good. The fundamentals in existential holistic therapy are that everybody has the potential for healing themselves to become loving, joyful, sexually attractive, strong, and gifted. While the patient is suffering and fighting to get through life, the most important job for the holistic therapist is to keep a positive perspective of life. Many participants in holistic group therapy have positive emotional experiences, of an unknown intensity to transform their lives.

An important idea of the course is Bohm’s concept of “holo-movement” in the group, resulting from intense coherence between the group members. When the group comes together, the individual is linked to the totality and the great movement forward towards love, consciousness, and happiness happen collectively — if it happens at all. This gives the individual the feeling that everything that happens is right, important, and valuable for all the participants at the same time.

Native Americans and other premodern people refer to this experience as “the spiritual design”, which is actually an underlying regulation that appears when people, through their feelings and engagement for each other, tie the group together and engage their complex emotional intelligence.

Practically, all participants are sunk in the same information matrix, so that everybody learns from each other. Everything that happens in the perception of each trainee has immediate and developing relevance. Spontaneous healing happens effectively in a group setting, where all the participants stand together and support each other, than it does in the clinic, where the therapist is alone with the patient. The domain of existential holistic therapy is the whole person, the holos, the soul, the deep self, higher self, real self, or simply the self, in contrast to the ego, false self, or illusory self.

Existential psychotherapy addresses the emotional aspect of the human mind related to death, freedom, isolation, and meaninglessness, while existential holistic therapy addresses the state of the persons wholeness. Existential holistic therapy is not psychotherapy, as it addresses the body, the person’s philosophy, and the spirit, to the same extent as it addresses the psyche, normally translated in practice to something like “the emotional mind.

### Contrary to the normal practice of existential psychotherapy, the development of a verbal consciousness and a sound personal philosophy is very important to existential, holistic therapy. Existential holistic therapy is not based on Freud’s concept of the sexual urge or the like, but on the concept of the purpose of life, which is embedded in the wholeness of the human being and not in any part of it.

### Existential holistic therapy makes an equal point on holding and processing and the belief that the healing of the human existence improves both health, quality of life, and the ability to function. Contrary to neoFreudian (interpersonal) psychodynamic theory, in existential holistic therapy it is assumed that the human being is a product of his or her intentions and, in particular, his or her original purpose of life and denial of this purpose. The holistic process theory is strongly inspired by Jung’s theory of the ego, the self, and the shadow. Existential, holistic therapy can be carried out in an individual or group setting.

### Although existential psychotherapy is rather depressive concerning the fundamental human conditions — life is basically meaningless, everybody is basically isolated, freedom is basically empty, and life is mostly a relentless enterprise ending up with death — existential holistic therapy is fundamentally positive. It looks at life as basically meaningful, joyful, powerful, wise, and coherent. This makes holistic therapy very different, and the feel of existential holistic therapy is much more “naive and innocent” than the somewhat “cynical and experienced” feel of existential psychotherapy.

### Narrative Therapy

Narrative therapy emerges from social constructivism, which assumes that events in life are inherently ambiguous, and the ways in which people construct meaning are largely influenced by family, culture, and society and people's lives, including their relationships, are shaped by language and the knowledge and meaning contained in the stories they hear and tell about their lives. New approaches to understanding psychological growth have emphasized using storytelling and mythology to enhance self-awareness.

Narrative therapy can be a powerful approach fort he patients in describing their lives and providing them with opportunities to gain insight into their life stories and to change those "scripts" that they find lacking. Storytelling is a way of articulating a subjective, experiential truth, and it is important for the therapist  to become aware of the significance of the story being told and its potential therapeutic value.

Narrative approaches to psychological healing have been used across various cultures for thousands of years. Contemporary approaches to narrative therapy recognize the importance of understanding how human experience becomes meaningful. A person's life is influenced by the narratives he/she constructs, which are in turn influenced by the narratives of those around. Therapy is viewed as a collaborative attempt to increase awareness of the ways in which events in the lives become significant. In effect, the therapist says, "Let's be curious about your story together."

The narrative approach often involves posing questions in a way that situates the problem as an external influence. "When the problem is externalized, it's as if the person can peek out from behind it". In substance abuse treatment, for example, questions such as can be asked, "How has substance abuse influenced your life?" or "Have there been times when you did not allow addiction to take over?" Such questions can help identify positive aspects and potential resources occurring in people's narratives that can be enhanced, as well as deficits that must be overcome.

**Transpersonal Therapy**

Transpersonal psychology emerged as a "fourth force" in psychology in the late 1960s and has strong roots in humanistic and existential psychologies, Jungian analysis, the East-West dialog, and ancient wisdom traditions. Transpersonal therapy may be thought of as a bridge between psychological and spiritual practice.

A transpersonal approach emphasizes development of the individual beyond, but including, the ego. It acknowledges the human spiritual quest and recognizes the human striving for unity, ultimate truth, and profound freedom. It cultivates intuitive ways of knowing that complement rational and sensory modes. This approach also recognizes the potential for growth inherent in "peak" experiences and other shifts in consciousness. Although grounded in psychological theory, transpersonal practitioners also tend to incorporate perspectives from ancient wisdom traditions.

The practice of transpersonal therapy is defined more by its orientation and scope rather than by a particular set of techniques or methods . Five postulates are suggested for a transpersonal psychotherapy:

1. Transpersonal psychotherapy is an approach to healing and growth that recognizes the centrality of the self in the therapeutic process.
2. Transpersonal psychotherapy values wholeness of being and self-realization on all levels of the spectrum of identity (i.e., egoic, existential, transpersonal).
3. Transpersonal psychotherapy is a process of awakening from a limited personal identity to expanded universal knowledge of self.
4. Transpersonal psychotherapy makes use of the healing restorative nature of subjective awareness and intuition in the process of awakening.
5. In transpersonal psychotherapy, the therapeutic relationship is a vehicle for the process of awakening in both client and therapist.

Transpersonal therapy recognizes the need for basic psychological development to be integrated with spiritual growth. Without such integration there is danger of "spiritual bypassing," where issues of basic psychological functioning are avoided in the name of spiritual development.

**Gestalt Therapy**

Gestalt theory holds that the analysis of parts can never provide an understanding of the whole. In a therapeutic setting, this approach opposes the notion that human beings can be understood entirely through a rational, mechanistic, scientific process, but only through the individual's direct experience and description to help to gain awareness of themselves and the world. Discomfort arises from leaving elements and experiences of the psyche incomplete-- primarily past relationships and intrapsychic conflicts that are unresolved. According to Gestalt theory

* The organism should be seen as a whole (physical behavior is an important component, as a mental and emotional life).
* Being in the "here and now" (i.e., being aware of present experience) is of primary importance.
* How is more important than why (i.e., causes are not as important as results).
* The individual's inner experience is central.
* For Gestalt therapists the "power is in the present" . This means that the "now" is the only place where awareness, responsibility, and change can occur. The process of therapy is to make a contact with the present moment.

Rather than seeking detailed intellectual analysis, the Gestalt therapist looks to create a "safe emergency" in the therapeutic encounter. To "lose the mind and come to the senses" implies that a feeling-level, "here and now" experience is the optimal condition for therapeutic work. This may be accomplished in a fairly short amount of time by explicitly asking (e.g., "What are you aware of now? How does your fear feel to you?").

The therapist may point out how the person avoids the present moment through inauthentic "games" or ways of relating such as "talking about" feelings rather than experiencing them directly , which can be done through exaggerating certain expressions (e.g., pounding a fist) or role-play certain internal dialogs (e.g., through an empty chair technique) to move people into the immediacy of the experience rather than remaining distant from it through intellectualization or substance abuse.

The term *contact* in Gestalt refers to meeting oneself and what is other than oneself. Without appropriate contact and contact boundaries there is no real meeting of the world. Instead, one remains either engulfed by the world on one hand or, on the other hand, distant from the world and people.

Substance abuse interrupts the flow of "organismic self-regulation." The result is that individuals do not achieve satisfaction of their needs and can remain unaware of what their needs are. The substance abuser may distort or thwart the natural cycle at any of the following points:

* Experiencing the need
* Mobilization of energy
* Contact
* Satisfaction
* Withdrawal
* Rest

Treatment involves bringing awareness to each of these dimensions and the strategies of avoidance.Substance abuse may also be understood as "introjection" in which the individual attempts to "swallow whole" or "drink in" his/her environment without contact and discrimination bypassing and blocking other experiences that might enable contact and the development of discrimination. This pattern of interaction extends to other relationships (besides the substance) as well. In order for this work to proceed, the therapist must maintain a fine-tuned, present-moment immediacy, even serving as a "resonance chamber" with his/her own reactions. (245-246)

**Holo-movement**

Holo-movement arose from the fusion of philosophical reflection and physical deception, questioning the reality of the physical laws we claim govern the universe, be it the stars in the sky, planetary motion, or the origin of the universe itself.Quantum mechanics deals on the subatomic level where Newton's laws of motion do not apply, giving clear explanations of physical phenomena and using mathematics to obtain quantitative, scientific results about the origins, structure, contents, and evolution of the universe. Quantum mechanics implies, metaphysically, that we create certain properties are created when they are chosen to be measured. In this sense, the universe itself (or our conception of it) is created by us.

The main difference between quantum mechanics and Newton's laws of motion is that Newton's laws predict events pertaining to real things, while quantum mechanics can only predict probabilities pertaining to subatomic phenomena undetectable by the senses. Quantum theory states that nature can be partitioned into quanta, "the minimum amount of any physical entity involved in an interaction", such as light. Quantum theory states that nature can be partitioned into quanta, "the minimum amount of any physical entity involved in an interaction", such as light. For example, light can be wave-like or particle-like. According to traditional science, these two properties cannot happen at the same time.

3

Quantum mechanics claim that light (and other elementary particles or quantic entities) can be described as both a particle and as a wave through the concept of wave-particle duality. They support this claim by adding that the wave-like and particle-like behaviors of the light are properties of our interaction with light; we have the choice to manifest particle-like properties or wave-like properties of light depending on our experiment.Bohm calls holomovement the "fundamental ground of all matter" and the "unknown and indescribable totality", enfolding and unfolding into infinite dimensionality within which independent sub-totalities (e.g. humans) exist . Internal structure, act essentially as amplifiers of information contained in a quantum wave"

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The universe is in a holographic or coherent vibratory form. The components that constitute space

"vibrate or oscillate perpetually due to axiomatic laws as a frozen hologram.Everything in the universe including space and time is in a coherent vibratory form, and are defined by electromagnetic energy moving in circles. The whole holomovement depends on time and space; objects are phenomenal parts of matter - an intense vibration of particles. The flow of enigma of holomovement is an intense electromagnetic energy field with a unison of cyclic time intervals. A hologram "is an image formed of vibrating nodes that remain in a stationery relationship to each other similarity, similar to how the vibrating particles composing a cube display the object's dynamic state

to maintain the form being projected” (Srinivasan, p. 16). A hologram possesses the quality of self-

No object can be created, bound, released, radiated, etc. but only interactive vibrations/stresses transmigrate across the identical components of the Substratum as vibratory phenomenon. The holomovement theory states that space oscillates at "an axiomatic rate of 296,575,967 [about 300,000,000] oscillations per cycle of 10 oscillations or 299,792,458 oscillations at a metre wavelength / second, which equals the velocity of light in vacuum". This calculation corrects the velocity of light traditionally expressed in physics by acknowledging the Doppler shift due to solar orbital velocity in the Milkyway Galaxy by a factor of 1.010845. The frequency of light is inconstant.

The universe is either changing its state by transmigration of stresses or oscillates in the same location as a frozen hologram. Planck mass, neutron or proton, electron mass ratio, the electromagnetic fields, spectral behavior of strong/weak EM forces, and all observable parameters are due to "vectorial aggregation of vibrations based on purely axiomatic principles that follow self similar and scale invariant laws".The holistic view proposed by the holo-movement theory asserts that everything emerges within a "super-symmetric, lowest entropy unified totality of nature"

The holo-movement theory, claims the Singularity is not just a "reductive notion of an infinitesimal point"; it is also "at the same time the holistic notion of infinite expanse: simultaneously infinity/point, wholeness/part, and universal/individual" . It possesses two qualities: Infinite dynamism and infinite silence. These qualities are integrated into one concept: Infinitely self-interacting (curving back upon itself). The big bang would be more of a small condensation to finite levels within an all-encompassing unified field. The axiomatic fact of the Universe is that each uniquely distant celestial object with a surface of revolution of the curve is in a coherent passive state, and creates a gravitational potential well.

The holomovement is an example of an implicate order and carries within it an implicate order. The word implicate comes from the verb to implicate, to fold inward. Reality as implicate means that any portion of it involves every other portion. Everything folds into everything, each part contains folded within it information on every other part. Each region contains the total structure of the universe, the whole. The content of the holomovement unfolds as the explicate world. In it, each part relates to the whol . Holonomy (the law of the whole) always limits the breaking of a situation into independent parts. They come from a more basic . whole and in the end are not separate.

**MOVEMENT IN THE UNIVERSE: FROM NONLOCALITY TO LOCALITY**

Nonlocality came first in the evolution of the universe described by quantum mechanics. Just after the Big Bang, nonlocality locked together all the particles in the universe. When the universe began to expand, the particles collided and caused locality. Locality and separation go hand in hand. In the explicate universe, there is a movement over time. It goes from nonlocality to locality, associated with the expansion of the universe. Although related, this movement is different from the continual folding and unfolding of the explicate order in to and out from the implicate.

The move from nonlocality to locality has gone so far that in the macroworld there is little nonlocality. Almost everything relates in a local or classical manner, the exceptions being at the quantum level .The appearance of locality from nonlocality produces entropy. Locality is at a lower energy level, than is nonlocality, because it is less organized-to start with, it does not have nonlocality. Increasing entropy is the second movement of the universe through time. The universe is winding down and scattering its energy; its history is irreversible.

A system is more nonlocal than its parts. This is because the whole causes the elements to behave in clusters, all together, or individually, in ways different from the ways they would behave by themselves. This causation is not a series of local interactions causing an apparent nonlocality. If this were the case, the actions of the parts would explain the holistic activities, and the whole would not be greater than the sum of its parts. One could say that the relating of separated elements for which there is no immediate physical contact is a form of nonlocality.

Nonlocality reemerges at the macrolevel, having seen the rise of locality near the beginning of the universe and its later domination. There has been a development over the life of the universe in two directions. One is the increase in entropy and locality, reflecting the increase of separation between objects and the winding down of the universe. The other is evolution leading to increasing complexity and the gradual increase of internal connections. This reflects the advent to a coherent world view that proclaims the universe as an unbroken wholeness, applicable to the whole, to everything without exception. Its application should be universal including not just the field of physics but also of biology and psychology. That means not simply wholeness in relation to the non-organic, but also wholeness in relation to organic life and the Singularity of Nature ( the way that nature appears to mesh interconnectedly)

The quantum principles of non-locality, entanglement and quantum coherences are active biological mechanisms and life on earth has been dependent on quantum processes from its earliest beginnings. Quantum coherence and entanglement have been shown to be the active operating means of excitation of the light harvesting complexes used by photosynthetic bacteria. The avian magnetic compass is dependent on quantum superposition and the quantum entanglement of particles, while cell–cell communication extends across an entire organism by a variety of quantum means. The interrelationship between the physical and biological realms is an established feature of ongoing processes.

The question of a coherent wholeness must include the ‘stateless subjects’ – meaning, mind, language and consciousness – that have been continually turnedback in their attempts to cross the Cartesian sea of separation and division by formal exclusions that try to prevent them from arriving at the ports of mainstream science. Hologram is created when coherent laser light is reflected (or scattered) from an object and collected on a photographic plate along with part of the original laser beam. The two beams interfere to generate a standing wave pattern which is recorded directly on the plate. The intensity on the photographic plate is the square of the sum of the amplitudes of the reflected (or scattered) light and the reference beam. After development, the photographic plate can be illuminated with a laser beam that interacts with the interference pattern to produce a three-dimensional image that looks like the original object, but this image appears upon a look through a window.

These interactive relationships between parts and whole that are produced by coherent light in holograms can be called symmetrical. That means these holographic relationships can be detailed as: ‘whole-to-part/part to whole’ relationships. In addition, the unifying force that holds the parts and the whole together is structured by a complex of whole-to-part/part-to-whole relations that exhibits a symmetrical force or unity. This force creates the indivisible unity of the hologram so that the parts, while still distinct are locked together into the whole image in ways that cannot be separated or divided into separate or linear series. Bohm used the example of the hologram to discuss the universal nature of wholeness in each region of space: ‘the movement of light implicitly contains a vast range of distinctions of order and measure, appropriate to a whole illuminated structure. Indeed, in principle, this structure extends over the whole universe and over the whole past, with implications for the whole future’.

The example of a hologram became an interactive model having a scope that takes in the whole of space and time of the universe. In this sense, this wholeness model incorporates everything in the universe. Bohm also developed his own theory of universal wholeness which was supported by the interactive character of the hologram. This was his theory of the implicate and explicate orders. The explicate order represents the explicit differential forms and objects (the parts) that move within the physical world of space and time and arise through the local mind’s processes of perception. Bohm’s implicate order represents the entire universal context of a singular, whole and unified interconnected system – an undivided universe. The entire implicate order can be described as having unifying qualities but devoid of quantities, rather quantities are the central feature of the explicate order.

The verb ‘to implicate’, means ‘to fold inwards. Bohm has speculated that each region of space and time ‘contains a total structure ‘enfolded’ within it’. The implicate order can be described as an enfolding order while in contrast, the explicate order unfolds from the implicate order the moving forms and objects of the explicit and physical universe. This means that all physical objects and forms observed to be moving in the continuum of space and time represent the explicate order, which unfolds from the implicate order. From a Cartesian perspective, the explicate order is the first and only order of importance.

Meaning has been understood as the by-product of signs, language, mind or intentionality tied to the conscious experience of phenomena. The context of the holomovement is that of consciousness and as the holomovement refers to everything in the universe it means that the context of the holomovement is universal consciousness. The universal context of the holomovement is entirely filled with the content and the conditions of meaning. This conclusion gives a coherent and meaningful depth to the holomovement. Implications represent the multiple possibilities that arise from every explicit action, behavior or expressions. (247)

**Transhumanism**

Transhumanism is a set of common ideals, or ideology, with the stated aim of transcending the current physical and mental limitations of the human by technological means. Proponents of transhumanism explicitly state that the current form of the species is not its final one, and a technologically enhanced computational form—transcending the human—will emerge through what they see as the inevitable and exponential acceleration of technoscience, especially in the areas of nanotechnology, biotechnology, and the informatic and cognitive sciences (NBIC) focusing on consciousness and an awakening universe as well.

The first re-uptake of the term ‘transhuman’ comes via the ‘father of cryonics’ (that is, the low temperature freezing and storage of human bodies), a physics teacher, Robert Ettinger., who published his own science fiction story about freezing and immortality in 1948 in hospital bed after being wounded in World War II. He shifted to non-fiction, describing the technical possibility of storing humans in cold freeze.

Cryonics has pushed the limits and utopian possibilities of science in remaking humans and society with a set of actual practices (storing bodies for the future), and the prospect of defeating death—the hardest of human and humanist limits to become transhumanism’s catchment site , attracting space enthusiasts, biologists, cryobiologists, physicists, writers, sci-fi enthusiasts, and, crucially, computer scientists. This assemblage, navigating the space between science and science fiction, a space that later came to be known as futurism, became the core of the transhumanist movement.

Without distinguishing between the organic and non-organic, cybernetics have examined the behaviour of complex systems in terms of feedback loops, wherein all behaviour could be gauged based on input and output signals which would then modify the system. The simplest example was a thermostat which could be thought of as self-aware, on some level, because it would constantly gauge and modify its behaviour based on information it received from the environment. All behaviour and communication, according to cybernetics , are based on such a loop, whether the system in question be biological or machinic, where information and feedback loops have been merged with behaviour and intelligence, blurring the boundaries that separated humans from  [animals](http://doi.org/10.29164/18animals), animals from machines, and inanimate matter from animate beings.

Ettinger, following cybernetics, suggested the continuation of personal identity beyond biological death through some version of non-organic or artificial intelligence (AI) where a human mind/self would be instantiated on non-biological platforms and cryonics and immortalism move beyond simple biological survival to imagine and claim such a post-human future. In the preface of his 1989 edition book, he marked a division with humanism: ‘What is happening is a discontinuity in history, with mortality and humanity on one side - on the other immortality and transhumanity’

As transhumanists gained ground and moved into powerful positions, their propositions for immortality, mind uploading, nanotechnology, space colonisation, and the expansion of consciousness into the cosmos have gained ground in the tech world. In turn Google’s founders created an academic-­biotech hybrid that they call an R&D company, the California Life Company (CALICO). providing nearly unlimited funding to a group of top researchers, like artificial-intelligence specialist Daphne Koller to do research into extending lives on the mantle of transhumanism and has funded biotech projects aimed at defeating death, or advancing brain mapping and mind uploading options.. Calico is an Alphabet-founded research and development company whose mission is to harness advanced technologies and model systems to increase the understanding of the biology that controls human aging and enable people to lead longer and healthier lives. .

Tesla and SpaceX founder Elon Musk have espoused transhumanism, whilst anti-aging researcher Aubrey de Grey transplanted his research organisation, the SENS Foundation, to Mountain View, California to emphasize the application of regenerative medicine to age-related disease, with the intent of repairing underlying damage to the body’s tissues, cells, and molecules and build the industry that will cure the diseases of aging. [Lifespan.io](http://lifespan.io/) (Life Extension Advocacy Foundation) and [SENS Research Foundation](https://sens.org/) have announced the completion of their merger.*Lifespan Research Institute (“LRI”) will develop, promote, and ensure widespread access to regenerative medicine solutions targeting the disabilities and diseases of aging, combining direct research efforts with robust education, affiliation, and outreach programs.*

Many things go wrong with aging bodies, but at the root of them all is the burden of decades of unrepaired damage to the cellular and molecular structures that make up the functional units of the tissues. As each essential microscopic structure fails, tissue function becomes progressively compromised – imperceptibly at first, but ending into the diseases and disabilities of aging. SENS Research Foundation’s strategy to prevent and reverse age-related ill-health is to apply the principles of regenerative medicine therapies that remove, repair, replace, or render harmless the cellular and molecular damage that has accumulated in the tissues with time *at Ethe level where it occurs*. Each of these kinds of damage make the bodies frail, and contribute to the rising frailty and ill-health. By reconstructing the structured order of the living machinery of the tissues, these rejuvenation biotechnologies will restore the normal functioning of the body’s cells and essential biomolecules, returning aging tissues to health and bringing back the body’s youthful vigor.

Through groundbreaking research in rejuvenation biotechnology that can repair and replace the damaged functional units ,SENS Research Foundation is catalyzing the development of new medical therapies to comprehensively address the disabilities and diseases of aging, leading to a reimagined aging in its SENS strategy – from the kinds of aging damage that occur, to their contribution to age-related frailty and illness,

The key aspects of the informatic theory of the universe are that

1. all matter is constituted, or at least can be captured and encoded, by information and complexity; since all matter, including the human brain, is constituted by and legible as patterns of information, there must be a continuum between not only human and nonhuman [animals](http://doi.org/10.29164/18animals) but also biological and nonbiological matter.
2. humans may be regarded as one instance of the evolution of the universe from simple to complex informatic formations, bound to be superseded by super-intelligence. And since computation can capture and modify information,
3. information in the informatic cosmos may be translated from one medium to another, making all mental states potentially transferrable across matter. [Minds](http://doi.org/10.29164/21mind) may be downloaded and uploaded, migrating from the electrochemistry of the brain to a computational platform, rendering the biological body obsolete. This latter is the task and promise of AI.

The matter and energy in our vicinity will become infused with the intelligence, knowledge, creativity, beauty and emotional intelligence (the ability to love, for example) of our human-machine civilization. The civilization will then expand outward, turning all the dumb matter and energy into sublimely intelligent—transcendent—matter and energy. This progression of intelligence over time and into all matter in the universe has also been called a ‘telos of rationality’ . Much of the scholarship on transhumanism has moved along two paths. The first is in relation to the enhancement and modification of the body (brains included) and, ultimately, of the nature of being human. Whereas transhumanists tend to dismiss emotions as irrational, cognitive neuroscience has shown the importance of emotions in good decision-making and creative thinking.

A second path has run along attempts to identify transhumanism as essentially a kind of religion. Resonances between Mormonism and transhumanism include attempts to resurrect the dead, the conviction that man can become god, and the possibility that humans live in infinitely simulated worlds. The similar affinities between transhumanism and an unlikely mix of emerging intellectual trends, such as the growing interest in panpsychism , the mixture of [animism](http://doi.org/10.29164/19anim) and technology in ‘techno-animist’ perspectives or the emergence of informatic selves , in which selves are increasingly understood and enacted through informational or algorithmic platforms that record one’s movements, choices, desires, or physiology as informational patterns.

Transhumanist cyborgs are interesting in their human-nonhuman ‘mangle’, but overall transhumanism starts from a very narrow premise regarding the kinds of possible mind-body capacities that exist and may be imagined for the future as powerful as a human-machine cyborg. While computationalism cultivates one aspect of possible powers called the ‘performative brain’, others may cultivate through other modalities, from psychedelic experiments to meditation. Transhumanists see humans as a specie whose nature is to change its nature, and breaking up the category ‘human’ presents the opportunity to transcend the ‘natural heritage’ and its limits . Transhumanism values only a specific form of intelligence or life, that is translatable and shapeable via computation . In this mode, the machinic and the computational are turned into their own reified nonbiological value. They are valued in and of themselves as though they were meaningful aside from the human social contexts in which they exist.

To transhumanists, the value of nonhuman superintelligence overrides human interests, and is encoded in efforts to achieve the vaunted *telos* of a posthuman techno-civilisation. What is valued over humanness in this informatic cosmology is the perpetuation of a *posthuman form of life*—in which the power, accuracy, and speed of computational technologies become the utmost measures of worth, supposed to lead to the rise of conscious beings

Transhumanism may be understood as a social project for claiming particular techno-libertarian futures, imagined as part of an inevitable and universal trajectory of intelligence and informatic complexity. Whereas these futures promise emancipation from the limitations of human biology and embodiment, including those of [race](http://doi.org/10.29164/23raceandracism), gender, and even [labour](http://doi.org/10.29164/24worklabour), they keep erasing and so in practice [reproducing](http://doi.org/10.29164/21socialrepro) the racial and settler [colonial](http://doi.org/10.29164/16colonialism) histories and on-going structural inequalities that undergird the development of such technologies and the accrual of power and wealth to a few. They follow the white mythos of the autonomous subject ‘whose freedom is in actuality possible only because of the surrogate effect of servants, slaves, wives, and, later, industrial service workers who perform this racialized and gendered labor’ In other words, whatever is invoked in the name of humanity or transhumanity, the futures idealised by transhumanists cannot be valued universally.

Transhumanist forms of life represent a danger, especially to those in already structurally [precarious](http://doi.org/10.29164/18precarity) situations (racially, geopolitically, by class, by status, by physical ability) as well as those engaged in political struggles that aim against the wider contemporary socioeconomic and civilisational formations.The projected transhumanist technologies often emerge from military research and are fed back into the military.Transhumanism is part of the wider set of posthumanisms that have ripped apart the common Enlightenment-era conjunction of person and human—that is, of an entity whose dignity and rights were premised on a notion of special consciousness that emphasised self-awareness, reason, and the ability to speak and act freely. If these features are not exclusively based in biological forms, and may be attributes of computational devices, then personhood is decoupled from exclusive humanism, and even multi-specieism, and its attributes and pursuant rights may be extended to what was previously thought of as inert or disenchanted matter. While the informatic cosmology of [mind](http://doi.org/10.29164/21mind) and cosmos allows transhumanists to move beyond the secular humanist disenchantment of matter and argue for such things as robot rights or intelligent matter in the universe, it narrows the possibilities of mind by fetishising algorithmic intelligence.

In the name of expanding human capacities and transcending human limits, algorithmic modalities are separating the technologically enhanced civilized, forms of life from regular old primitive *Homo sapiens*, without acknowledging the social and [historical](http://doi.org/10.29164/21history) conditions that enable enhancement.Human socialities and possible lifeways are erased from that future, and a particular human subjectivity is being produced by the mediation of computational devices that makes for a recursive loop of algorithmic affirmation to teach with computers how to behave computationally and value computational behaviour. What is noticeable in the meantime is that as transhumanism has gotten increasingly entrenched in the tech world’s networks of power, its discourse, anxieties, and projects have become harder to distinguish from those of the military, [scientific](http://doi.org/10.29164/16science), technological, and [financial](http://doi.org/10.29164/25finance) institutions of late capitalism: existential risk, space colonies, neural implants, robotic automation, avatar selves, and mind uploading have moved from being the maligned concerns of a few technofuturists to more common, popular goals of a post-human future..    (248)

**REJUVENATIVE MEDICINE**

Cells can be rejuvenated and biological clocks reset using cellular reprogramming.The ageing process is a systemic decline from cellular dysfunction to organ degeneration, with more predisposition to deteriorated disorders. Rejuvenation refers to giving aged cells or organisms more youthful characteristics through various techniques, such as cellular reprogramming and epigenetic regulation. The great leaps in cellular rejuvenation prove that ageing is not a one-way street, and many rejuvenative interventions have emerged to delay and even reverse the ageing process.

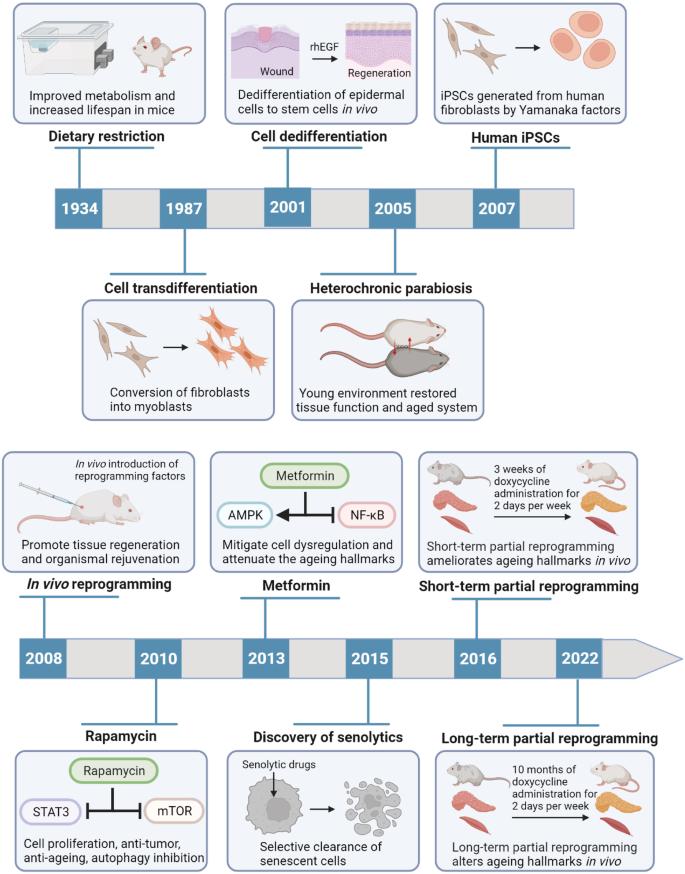


Fig.31. The milestone events for cellular rejuvenation research advances. Starting with the 1934 discovery of the influence of dietary restriction on lifespan extension, important findings on the subject of cellular rejuvenation are emphasized. The senolytics development and reprogramming technology have been widely applied for cellular rejuvenation. rhEGF recombinant human epidermal growth factor, iPSCs induced pluripotent stem cells, AMPK 5’-AMP-activated protein kinase, NF-κB nuclear factor-κB, STAT3 signal transducer and activator of transcription 3, mTOR mammalian target of rapamycin. Created with BioRender.com

Different organisms share certain molecular and cellular characteristics that are indicative of ageing, such as cellular senescence, epigenetic changes, telomere attrition, genomic instability, stem cell exhaustion, deregulated nutrient sensing, loss of proteostasis, mitochondrial dysfunction, and altered intercellular communication. Alterations in physiological and pathological ageing, are caused by disruptions in genetic and epigenetic mechanisms. The universal definition of epigenetics is heritable genomic functionally modifications without DNA sequence variations. Gene expression and chromatin structure are connected with the major epigenetic alterations, which include DNA methylation, histone modifications, and noncoding RNA regulation. Defective transcriptional and chromatin networks have highlighted the contribution to cellular function, stress resistance, and ageing. Epigenetic alterations and genetic instability may affect all cells and tissues in the anti-ageing process.

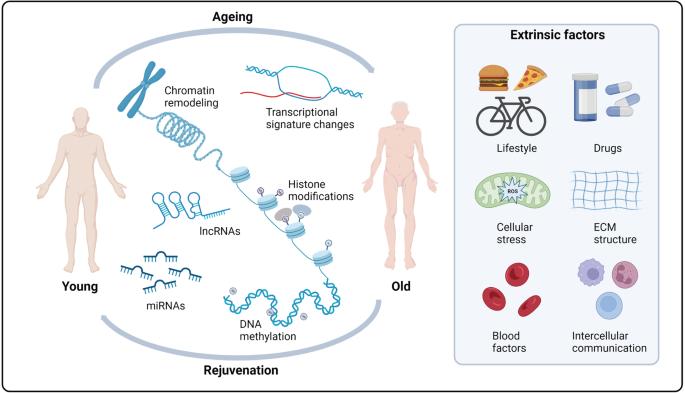


Fig.32. The epigenetic states of ageing and rejuvenation. Ageing and rejuvenation can be affected by intrinsic epigenetic alterations and genetic instability, like DNA methylation and chromatin remodeling. Many extrinsic factors, like microenvironmental cues, intercellular communication, and systemic factors, can also impact the epigenetic states of ageing and rejuvenation. miRNAs microRNAs, lncRNAs long noncoding RNAs, ECM extracellular matrix. Created with BioRender.com

The specific complex of cell macromolecules, including telomeres, proteins, and lipids, possesses intrinsically high resistance to modification, contributing to superior longevity in species. Reducing macromolecular damage is associated with an improvement in the majority of ageing-related physiological activities.

The single macromolecular regulator of ageing and the interconnectivity among molecular phenotypes can both induce alterations in ageing-related phenotypes, limiting cell rejuvenation.Proteome homeostasis is maintained by the proteostasis network (PN), a macromolecular system that coordinates protein synthesis, folding, disaggregation, and degradation for organismal health and longevity. The autophagy-lysosomal system and the ubiquitin-proteasomal system (UPS) are two crucial mechanisms that regulate the turnover of organelles and aggregates.Proteasomes are also charged with removing normal and damaged proteins, participating in the evolutionarily conserved ageing mechanism and longevity regulation.

Ageing often shifts the balance between the protein lifecycle in organisms, resulting in pathology. UPS dysregulation occurs in the ageing process and ageing-related diseases in mammals. PN component aggregation during ageing can elicit aberrant transcriptional procedures, reduced folding capacity, and the accumulation of misfolded species.This loss of proteostasis may further have profound consequences for ageing progression and age-related disease presentation. In addition, the increased ribosome pausing during ageing can also make the ribosome-associated quality control overloaded, leading to proteostasis impairment and systemic decline.

Age-dependent alterations in the transcriptomes, proteomes, and metabolomes of different organisms and tissues reveal the imbalance of metabolic homeostasis. Remodeling of metabolic signals and metabolites in ageing and the control of lifespan is caused by organelle malfunction, redox imbalance, and changed signaling pathways. Both environmental and generated endogenous toxicants by metabolism are major contributors to macromolecular damage and physiological dysregulation during ageing. The metabolic phenotyping of ageing mice revealed the involvement of the adiponectin, growth hormone, and cytokine pathways in autophagy, stress response, genome integrity, mitochondrial biogenesis, energy balance, inflammation, and infection control.

The main mechanism to foster ageing is the malfunctioning of vital cellular organelles, including the autophagosomal-lysosomal network and mitochondria. With advancing age, there is a reduction in autophagy activity, autophagosome production rate, and lysosome fusion activity. Insufficient protective autophagy during ageing may cause damaged cellular components to accumulate and dysfunction of cellular organelles, leading to metabolic imbalance and further ageing. Moreover, defective mitochondrias produce insufficient ATP and frequently produce more ROS to enhance oxidative stress Aged cells commonly develop mitochondria with aberrant characteristics, such as point mutations and mitochondrial DNA (mtDNA) deletions. In addition, mitochondrial metabolism also includes carbon metabolism (the tricarboxylic acid (TCA) cycle), the biosynthesis of Fe/S clusters, and the metabolic consequences of mitophagy.  These metabolic processes are highly dynamic and all influence different facets of ageing.

Intercellular communication networks are essential for the coordination of biological processes in healthy and pathological settings of multicellular organisms. Senescence and ageing are influenced by interferences with intercellular communication caused by metabolic, mechanical, or biochemical triggers. To sustain physiologic function and respond to diseases, many cell types that form the neurovascular unit (NVU) are in constant contact. The insufficient crosstalk between NVU cells impairs neurovascular coupling and blood-brain barrier dysfunction, thus leading to ageing and related neurological and neurovascular diseases.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR74)*There* are also many organelle-organelle and organelle-cytosol communications impacting chronological ageing. These communications form an intricate network involving various movements of metabolites between cellular compartments. The process of stem cell ageing and tissue and organ functional declining is attributed to mitochondrial-ER crosstalk.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR75)Senescent cells are extremely proactive and interact with nearby cells through a variety of intercellular channels

Alterations in the systemic environment of cells and tissues play a role in the reversible process of ageing. Organ dysfunction with ageing is caused by blood-mediated cell-extrinsic alterations and important molecular mechanisms in the systemic environment. With increasing age, decreased stem cell functionality can lead to diminished organ function and prolonged tissue repair. Targeting the age-related molecular basis of stem cells may reduce the deleterious effects of ageing. There are many rejuvenating approaches based on aged stem cells, such as delayed fasting, gene expression modulation, medicinal intervention, and niche changes.Senescent cells (SCs) comprise a heterogeneous cell population because of their various cell-autonomous activation pathways and microenvironmental circumstances.

Although cell-cycle arrested, SCs are still metabolically active and can perform various functions of the parent cells. SCs, as organismal carriers of irreparable damage, are identified by the senescence-associated gene expression. During ageing, the immune system progressively undergoes disorders of immune cell generation, differentiation, and function, leading to a chronically. There are various signaling pathways identified in the fields of ageing and rejuvenation, such as nutrient-sensing pathways, DNA damage pathways, ROS and mitochondrial unfolded protein response (UPRmt) pathways, inflammation-related pathways, transforming growth factor-β (TGF-β) pathways and Wnt/β-catenin pathways. The known role of these signaling pathways is complex and mutually connected. Given the prominent association of signaling pathways with rejuvenation and ageing, targeting these signaling systems pharmacologically and therapeutically has great potential for rejuvenation and human health.

Metabolic stress, hypoxia, protein damage, and mitochondrial ROS all can impair mitochondrial protein homeostasis and functions. The transcriptional activation program of mitochondrial chaperone proteins and proteases is known as the mitochondrial unfolded protein response (UPRmt), which is a mitochondrial response to stress.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR139) Studies have shown that UPRmt plays a significant role in many physiological processes and that its activation increases longevity and prevents ageing by regulating mitochondrial proteostasis.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR140) During mitochondrial dysfunction, there are many transcription factors necessary for the activation of UPRmt genes in mammals. Activating transcription factor associated with stress-1 (ATFS-1) participates in the upregulation of genes involved in multiple stress response pathways for organismal survival of acute stressors.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR141) But, chronic ATFS-1 activation also has a negative effect on longevity.

**M**ultiple signaling cascades whose integration targets the induction of senescence, ageing, and associated disorders can be activated by the cycle of physiological interactions between inflammation and oxidative stress. Many studies clarified that ageing constitute critical barriers to cell reprogramming due to cellular senescence, inflammation, telomere reduction, and metabolic alterations.Lineage reprogramming, described as direct reprogramming, is the procedure of switching somatic cells from one lineage to another with no transition for intermediate pluripotent states.This method of cell reprogramming generates particular cell types by ectopically expressing various lineage-specific transcription factors or miRNAs.

Research has demonstrated that certain pro-neural transcription factors can directly reprogram non-neural somatic cells into neurons, skipping the pluripotent stage.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR185) Lineage reprogramming techniques can be used to create a variety of cell types, including brain, cardiac, hepatic, and pancreatic cells. Because of the unique advantages of in situ conversion in live organs, lineage reprogramming is efficient and suitable for in vivo tissue repair and rejuvenation. Direct reprogramming in vivo may also benefit from minimizing hazards for genetic changes during prolonged in vitro culture, cancer development associated with de-differentiation, and immunological rejection following transplantation.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR116)The senescent program induced by ageing process and tissue damage can offer a beneficial microenvironment for in vivo lineage reprogramming.

It is difficult to distinguish between the underlying epigenetic alterations that rejuvenate ageing cells and the changes that regulate the shift in cellular identity. Partial reprogramming is able to restore the common features of cellular ageing without altering the identity or function of the cells.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR192)  Epigenetic remodeling is associated with biochemical modifications to the genome, leading to an altered response of gene transcription to physiological stimuli. DNA methylation clocks detect a wide range of ageing-related epigenetic modifications that are indicative of genomic, cell biological, and tissue changes that occur during life.Epigenetic clocks can be more accurate than chronological clocks at estimating biological age, which aids in predicting human lifetime via age-reprogramming therapies. Protein-protein interactions can induce allosteric regulatory sites in complicated epigenetic machinery.

Ageing is unavoidably accompanied by a diminished capacity to maintain tissue integrity and function. Cell or tissue rejuvenation without dedifferentiation is known as epigenetic rejuvenation, and it leads to a more youthful functional state and reversed ageing molecular markers.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR214) The central epigenetic regulatory mechanisms are based on the enzymes that modulate DNA and histones (methyltransferases, demethylases, acetyltransferases, deacetylases).  The epigenome reprogramming can initiate ageing plasticity during heterochronic parabiosis, caloric restriction, or cellular reprogramming.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR215) These epigenetic modifications exhibit a strong capability of youthful function restoration in aged cells. In addition, epigenetic modifications can target several druggable pathways. In addition, senotherapy can increase lifespan, restore the functionality of bone marrow, muscle, and skin progenitor cells, enhance vasomotor function, and decrease the onset of atherosclerosis.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR216)

Autophagy is a conserved, physiologic, and self-protective mechanism that supports cellular homeostasis and stress adaption. Autophagosomes with bilayered membrane vesicles can capture the degraded cellular components and subsequently merge with the lysosome to digest long-lived proteins, excess or damaged organelles, and misfolded or aggregation-prone proteins.There are three distinct forms of autophagy, namely macroautophagy, microautophagy, and chaperone-mediated autophagy. Depending on the selective autophagic degradation of several organelles, autophagy is subdivided into mitophagy, aggrephagy, pexophagy, reticulophagy, nucleophagy, lysophagy, xenophagy, lipophagy, ferritinophagy, and glycophagy.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR237) The autophagy process is important for maintaining cellular energetics, cellular reprogramming, organellar remodeling, immunity regulation, metabolism, and cellular survival.Autophagy serves as one of the central pathways in the protection against functional loss and increased vulnerability to ageing process and age-related disorders. The activity of autophagy and the autophagy gene transcription by specific transcription factors, epigenetic changes, and microRNAs have emerged as crucially conserved pathways for promoting lifespan.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR238)

In autophagy pathways, multiple points with age including autophagosome biogenesis, cargo loading, intracellular transport, and autophagosome-lysosome fusion or acidification have shown ageing or disease-associated deficits. Enhancing the function of the autophagy-lysosome system can eradicate age-related organelle degeneration, which has regenerative benefits for cellular rejuvenation. Stem cells contain a functional circadian clock whose rhythmicity contributes to the multipotent cell properties in constant renewal and injury response.

Multipotent stem cells from various organs also have distinct clock gene expression profiles with various amplitude ranges.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR250) Meanwhile, dephased oscillators can provide stem cells the source of heterogeneity, to respond effectively to varied cues.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR251) Numerous embryonic and adult stem cell-dependent activities, including hematopoietic progenitor cell migration, follicular cycle, osteogenesis, regenerative myogenesis, and neurogenesis, have been linked to rhythmic oscillations and circadian clock regulation.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR252)

 The regulation of stem cell division and differentiation by the circadian clock is crucial for adult tissue regeneration. Histone alterations, DNA modifications, non-coding RNAs, huge multisubunit chromatin remodeling complexes, and additional epigenetic changes are also significant points in the circadian modulation of stem cell destiny.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR250)With ageing, stem cells receive signals from endogenous and external factors operated through circadian rhythms and epigenetic clocks. The circadian output and oscillator system have adapted to the particular homeostatic requirements of the adult stem cell region in the young organism.

But the circadian functions of ageing stem cells switch toward a stress-dominated program.The oscillations of peripheral clocks in numerous peripheral tissues, including the heart, liver, adipose tissue, retina, and multiple brain regions, can be controlled by synchronizing the circadian clock produced by SCN neurons.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR255) Meanwhile, there is a portion of transcripts expressed cyclically in each peripheral tissue, controlling the function of peripheral tissues  These tissue-specific circadian genes govern biological processes necessary for the preservation and dynamic modification of organ functions during the circadian cycle. Cell-autonomous circadian oscillations also have a substantial impact on the physiology and pathology of peripheral organs.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR257) In addition, the diurnal pattern of the light-dark cycle has a significant effect on the central SCN clock, while the feeding-fasting rhythm constrains the circadian rhythm of peripheral tissues.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR258)

Many studies have suggested that circadian rhythms might be in a noticeably different phase during development in one cell or tissue type compared to another part of the body.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR259) Circadian programs are tissue-specific and even varied in the same tissue under distinct physiological states.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR260) During ageing, diminished or asynchronous circadian oscillations can alter signaling networks and tissue-specific gene expression profiles. These alterations in tissue-specific clocks affect immune hyperactivation with ageing.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR261)  The tissue-specific targeting of clock subunits by pharmaceutical techniques might aid to the treatment of age-related diseases and recover circadian coherence with a chronically disrupted clock. Besides, tissue susceptibility and reactions to toxicity also change during the circadian cycle, which indicates the development of drug timing administration.

The molecular mechanisms that mediate cellular and organ ageing provide therapeutic targets for cellular rejuvenation such as cellular reprogramming, clearance of SCs and SASP inhibitor, metabolic manipulation, the restoration of aged stem cell function, microenvironment remodeling, resetting the circadian clock, immune rejuvenation, and heterochronic parabiosis. Especially, cellular reprogramming can rejuvenate the terminally differentiated cells to the pluripotent state or epigenetically unstable intermediates to another desired cell type for tissue repair. The reprogramming technology mainly includes iPSCs, partial reprogramming, and direct reprogramming

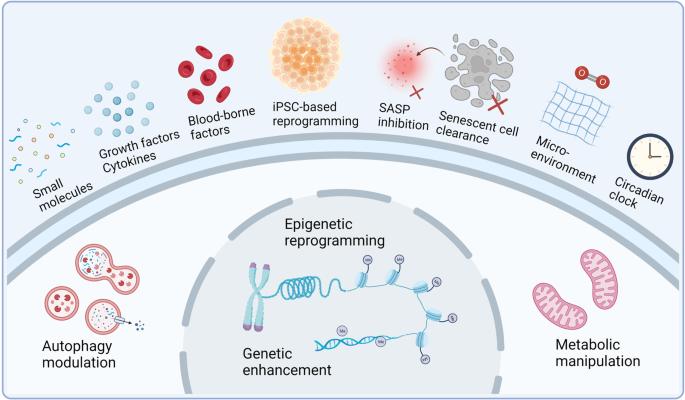


Fig.33.Schematic overview of strategies for cell rejuvenation. Various strategies have been developed for cell rejuvenation that leverage intrinsic and extrinsic factors, including epigenetic reprogramming, genetic enhancement, autophagy modulation, and metabolic manipulation. Small molecules, growth factors and cytokines, blood factors, iPSC technology, clearance of senescent cells and SASP, microenvironment regulation, and circadian clock modulation can also exert great influences on cell rejuvenation. iPSCs induced pluripotent stem cells, SASP senescence-associated secretory phenotype. Created with BioRender.com

The biological age of the cells, tissues, and organs is determined by an epigenetic clock based on alterations in the DNA methylation profile Using partial reprogramming, the epigenetic age of cells can be reduced without losing cell identity. To maintain genomic integrity and tissue homeostasis, adult tissue-specific stem and progenitor cells have defensive mechanisms that reduce endogenous DNA damage. However, the DNA repair response in stem cells declines with ageing, which results in the loss of stem cell properties and DNA damage-caused cellular senescence and organ atrophy.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR312) Identifying a suitable target to promote DNA repair may contribute to rescuing the DNA damage-induced function loss in aged stem cells.

Physiologically, extracellular signaling molecules are cues, such as EVs, neurotransmitters, growth factors, hormones, and cytokines, designed to transmit specific information to target somatic cells or adult stem cells. EVs function as a cutting-edge tool for stem cell rejuvenation because of their ability to transfer genes safely and with systemic effects. Injured tissue has a hostile environment, including inflammation, immune impairment, hypoxic stress, and poor blood supply, which degrades stem cell function, promotes cellular senescence, and results in a low survival rate of transplanted stem cells in vivo. Therefore, it is essential for stem cells to remain viable and maintain their potency before inducing a strong repair response. The optimization of the culture environment, such as hypoxic pretreatment, may achieve preconditioning-induced protection for stem cells.[https://www.nature.com/articles/s41392-023-01343-5](https://www.nature.com/articles/s41392-023-01343-5#ref-CR331) The oxygen tensions in natural cell microenvironments appear to be substantially lower.

The extracellular microenvironment’s chemical and mechanical characteristics are sensed by tissue-specific cells, which then produce responses that control a variety of cellular processes, such as expansion, migration, and differentiation, and activation, further maintaining tissue homeostasis. Intercellular communication has double-edged–sword activities, contributing to tissue homeostasis maintenance but also detrimental in ageing and related diseases, and altered intercellular communication has been the hallmark of ageing.

 One of the most prominent and important changes in intercellular signaling that occurs with age is “inflammageing”. The dominant role of inflammation in ageing-related intercellular communication raises the potential of anti-inflammatory agents in lifespan. Circadian clock-associated genes modulate the extrinsic and intrinsic mechanisms in lifespan modulation and organ ageing. The circadian clock in intervertebral discs (IVDs) is functional and temperature-entrainable.Numerous parts of human physiology are regulated by the circadian rhythm, opening up windows for interventions that can be made by only giving medications when their targets are at the proper expression level to rescue.

There is growing interest in developing small molecules that directly target the circadian system for medicinal benefits. Immune system is interconnected with all the other systems in the body, and this systemic nature provides the potential opportunity that targeted modifications to a small group of cells (e.g., HSCs or T lymphocytes) for improving the health of various organ systems.Tissue regeneration refers to the partial regeneration of an organism’s tissue that has been injured by external stimuli, which resulted from the regulation of tissue-residing cells and tissue microenvironment. Cellular rejuvenation for tissue regeneration is devoted to the enhancement of tissue-specific cell function and the regulation microenvironment.

Throughout human history, the quest to extend lifespan or restore youthful state has been relentless. With the enormous progress in medical technology, including a deeper understanding of cell senescence and age-associated pathophysiology, it has become plausible to extend the human lifespan while preserving health. It is extremely essential to gain insight into the basic principles regulating cellular rejuvenation. For decades, one of the dominant theories in ageing research has been that ageing results from the accumulation of DNA changes, mainly genetic mutations, which prevent more and more genes from functioning properly over time. These malfunctions, in turn, can cause cells to lose their properties, leading to the breakdown of tissues and organs and ultimately to ageing and diseases.

The emerging evidences claim that epigenetic information loss over time is the major cause of mammalian ageing, and epigenetic regulation can restore youthful gene expression patterns. Current advances have provided a comprehensive and detailed multi-level epigenetic panorama of ageing, elucidated some common and unique characteristics of physiological ageing and ageing-related diseases, identified novel biomarkers of ageing, and revealed new mechanisms of epigenetic remodeling in cell and organ ageing. Especially, with the development of epigenetic editing technology, scientists can make specific perturbations to the epigenome, to distinguish the causal relationship between the three-dimensional structure of chromatin and cell function. Epigenetic changes caused by ageing in more diverse cell types and pathophysiological states should also be extensively explored to discover conditional regulation mechanisms of ageing. For epigenetic rejuvenation, developing safe and stable strategies that modulate the epigenetic landscape of aged cells to a primitive state are important for cells to exert rejuvenating effects without cancer risk.

Ageing is a dynamic and time-varying process, typically manifested by cell damage accumulation, degeneration of tissue and organ structure and function, and increased susceptibility to diseases and is closely associated with many chronic diseases, like diabetes, Alzheimer’s disease (AD), chronic kidney diseases (CKD), cardiovascular diseases (CVD), and cancer. Dietary restriction (DR) was found to prolong lifespan in mice and rats in 1934, and there are currently many emerging rejuvenation treatments to enhance health and lengthen lifespan, such as genetic, pharmacological, dietary, and lifestyle modifying approaches . The ageing process is a systemic decline from cellular dysfunction to organ degeneration, with more predisposition to deteriorated disorders. Rejuvenation refers to giving aged cells or organisms more youthful characteristics through various techniques, such as cellular reprogramming and epigenetic regulation. The great leaps in cellular rejuvenation prove that ageing is not a one-way street, and many rejuvenative interventions have emerged to delay and even reverse the ageing process. (249-251)

**Regenerative medicine,**

Organ and tissue loss through disease and injury motivate the development of therapies that can regenerate tissues and decrease reliance on transplantations. Regenerative medicine, an interdisciplinary field that applies engineering and life science principles to promote regeneration, can potentially restore diseased and injured tissues and whole organs. Regenerative medicine has the potential to heal or replace tissues and organs damaged by age, disease, or trauma, as well as to normalize congenital defects. The field of regenerative medicine encompasses numerous strategies, including the use of materials and de novo generated cells, as well as various combinations thereof, to take the place of missing tissue, effectively replacing it both structurally and functionally, or to contribute to tissue healing . The body's innate healing response may also be leveraged to promote regeneration, although adult humans possess limited regenerative capacity in comparison with lower vertebrates .

Materials are often an important component of current regenerative medicine strategies because the material can mimic the native extracellular matrix (ECM) of tissues and direct cell behavior, contribute to the structure and function of new tissue, and locally present growth factors.Because tissue and organ architecture is deeply connected with function, the ability to recreate structure is typically believed to be essential for successful recapitulation of healthy tissue .

One strategy to capture organ structure and material composition in engineered tissues is to decellularize organs and to recellularize before transplantation. Decellularization removes immunogenic cells and molecules, while theoretically retaining structure as well as the mechanical properties and material composition of the native extracellular matrix. This approach has been executed in conjunction with bioreactors and used in animal models of disease with lungs, kidneys, liver, pancreas, and heart . Decellularized tissues, without the recellularization step, have been used to repair large muscle defects in a human patient. A variation on this approach involves the engineering of blood vessels in vitro and their subsequent decellularization before placement in patients requiring kidney dialysis .

Mechanical properties of tissues and organs may be affected by the decellularization process, the process may remove various types and amounts of ECM-associated signaling molecules, and the processed tissue may degrade over time after transplantation without commensurate replacement by host cells.The detergents and procedures used to strip cells and other immunogenic components from donor organs and techniques to recellularize stripped tissue before implantation are actively being optimized.Synthetic scaffolds may also be fabricated that possess at least some aspects of the material properties and structure of target tissue Scaffolds have been fabricated from naturally derived materials, such as purified extracellular matrix components or algae-derived alginate, or from synthetic polymers, such as poly(lactide-coglycolide) and poly(ethylene glycol); hydrogels are composed largely of water and are often used to form scaffolds due to their compositional similarity to tissue . These polymers can be engineered to be biodegradable, enabling gradual replacement of the scaffold by the cells seeded in the graft as well as by host cells .

This approach was used to fabricate tissue-engineered vascular grafts (TEVGs), which have entered clinical trials, for treating congenital heart defects in both pediatric and adult patients . It was found using animal models that the seeded cells in TEVGs did not contribute structurally to the graft once in the host, but rather orchestrated the inflammatory response that aided in host vascular cells populating the graft to form the new blood vessel . Biodegradable vascular grafts seeded with cells, cultured so that the cells produced extracellular matrix and subsequently decellularized, are undergoing clinical trials in the context of end-stage renal failure (Humacyte). Scaffolds that encompass a wide spectrum of mechanical properties have been engineered both to provide bulk mechanical support to the forming tissue and to provide instructive cues to adherent cells . For example, soft fibrin–collagen hydrogels have been explored as lymph node mimics whereas more rapidly degrading alginate hydrogels improved regeneration of critical defects in bone

The polymer's mechanical properties are believed to produce a therapeutic effect. For example, implantable alginate hydrogel (Algisyl-LVR™) treatment in combination with coronary artery bypass grafting (i.e. Algisyl-LVR™+CABG) on both LV function and wall stress in heart failure patients reduced the progression of heart failure in models of dilated cardiomyopathy. Materials with different properties can enhance scaffold performance, as was the case of composite polyglycolide and collagen scaffolds that were seeded with cells and served as bladder replacements for human patients .

In another example, an electrospun nanofiber mesh combined with peptide-modified alginate hydrogel and loaded with bone morphogenic protein 2 improved bone formation in critically sized defects. Medical imaging technologies such as computed tomography (CT) and magnetic resonance imaging (MRI) can be used to create 3D images of replacement tissues, sometimes based on the patient's own body. These 3D images can then be used as molds to fabricate scaffolds that are tailored specifically for the patient. For example, CT images of a patient were used for fabricating polyurethane and polyethylene-based synthetic trachea, which were then seeded with cells .

Small building blocks, consisting of cells embedded in a small volume of hydrogel, can also be assembled into tissue-like structures with defined architectures and cell patterning using a variety of recently developed techniques .To contribute functionally and structurally to the body, implanted grafts need to be properly integrated with the body. For cell-based implants, integration with host vasculature is of primary importance for graft success. Most cells in the body are located within 100 μm from the nearest capillary, the distance within which nutrient exchange and oxygen diffusion from the bloodstream can effectively occur To vascularize engineered tissues, the body's own angiogenic response may be exploited via the presentation of angiogenic growth factors. A variety of growth factors have been implicated in angiogenesis, including vascular endothelial growth factor (VEGF), angiopoietin (Ang), platelet-derived growth factor (PDGF), and basic fibroblast growth factor (bFGF) .

Another approach to promote graft vascularization at the target site is to prevascularize the graft or target site before implantation. Endothelial cells and their progenitors can self-organize into vascular networks when transplanted on an appropriate scaffold Combining endothelial cells with tissue-specific cells on a scaffold before transplantation can yield tissues that are both better vascularized and possess tissue-specific function It is also possible to create a vascular pedicle for an engineered tissue that facilitates subsequent transplantation; this approach has been demonstrated in the context of both bone and cardiac patches by first placing a scaffold around a large host vessel or on richly vascularized tissue, and then moving the engineered tissue to its final anatomic location once it becomes vascularized at the original site . This strategy was successfully used to vascularize an entire mandible replacement, which was later engrafted in a human patient Microfluidic and micropatterning techniques are currently being explored to engineer vascular networks that can be anastomosed to the femoral artery

Administration of cells can induce therapeutic responses by indirect means, such as secretion of growth factors and interaction with host cells, without significant incorporation of the cells into the host or having the transplanted cells form a bulk tissue. For example, infusion of human umbilical cord blood cells can aid in stroke recovery due to enhanced angiogenesis which in turn may have induced neuroblast migration to the site of injury. Similarly, transplanted macrophages can promote liver repair by activating hepatic progenitor cells. Although the goal of regenerative medicine has long been to avoid rejection of the new tissue by the host immune system, it is becoming increasingly clear that the immune system also plays a major role in regulating regeneration, both impairing and contributing to the healing process and engraftment.

At the extreme end of immune reactions is immune rejection, which is a serious obstacle to the integration of grafts created with allogeneic cells. Embryonic stem (ES) cells and induced pluripotent stem (iPS) cells represent potentially infinite sources of cells for regeneration and are moving toward clinical use ES cells are derived from blastocyst-stage embryos and have been shown to be pluripotent, giving rise to tissues from all three germ layers. Considerable research has enabled the fabrication of sophisticated grafts that exploit properties of scaffolding materials and cell manipulation technologies for controlling cell behavior and repairing tissue. These scaffolds can be molded to fit the patient's anatomy and be fabricated with substantial control over spatial positioning of cells. Strategies are being developed to improve graft integration with the host vasculature and nervous system, particularly through controlled release of growth factors and vascular cell seeding, and the body's healing response can be elicited and augmented in a variety of ways, including immune system modulation. New cell sources for transplantation that address the limited cell supply that hampered many past efforts are also being developed.

Regenerative medicine is an emerging field that harnesses the body’s own healing capacity to enhance tissue recovery, decrease pain, and improve functionality. Since the first use of the human body’s own cells for hematopoietic stem cell transplantation in 1957, several historical advancements have been achieved in the field of regenerative medicine including: allogeneic skin tissues in 1998, gene therapy to treat severe combined immunodeficiency (SCID) in 1990,[3](https://www.dovepress.com/evidence-based-clinical-practice-guidelines-on-regenerative-medicine-t-peer-reviewed-fulltext-article-JPR#cit0003) and development of cellularized scaffolds to replace tissues in 2016. Similarly, the integration of regenerative medicine into the field of pain has also surged over the past decade, supported by preclinical and clinical studies.

Regenerative medicine comprises approaches such as cell-based therapy, gene therapy, and tissue engineering that influence cell proliferation, interaction, and extracellular matrix restoration. Within pain management, regenerative medicine is employed as a treatment for a spectrum of conditions ranging from musculoskeletal conditions to neuropathic pain to spinal cord injury. Proposed mechanisms of action involve mobilizing inflammatory cells and secretion of cytokines and growth factors that play pivotal roles in tissue regeneration and maturation, and acting as natural anti-inflammatory agents. The pillars of regenerative medicine treatments in pain management include non-culture-expanded autologous MSCs from products such as bone marrow aspirate concentrate (BMAC) or fat aspirate, PRP, and their derivates Currently, only 36 more than “minimally manipulated” cell and gene therapies are approved by the Food and Drug Administration (FDA), primarily targeting cancer, inherited genetic diseases, and allogeneic umbilical cord cell transplantation.

Applications of regenerative medicine technology may offer novel therapies for patients with injuries, end-stage organ failure, or other clinical problems. Currently, patients suffering from diseased and injured organs can be treated with transplanted organs. However, there is a severe shortage of donor organs that is worsening yearly as the population ages and new cases of organ failure increase. Scientists in the field of regenerative medicine and tissue engineering are now applying the principles of cell transplantation, material science, and bioengineering to construct biological substitutes that will restore and maintain normal function in diseased and injured tissues. The stem cell field is also advancing rapidly, opening new avenues for this type of therapy. For example, therapeutic cloning and cellular reprogramming may one day provide a potentially limitless source of cells for tissue engineering applications. While stem cells are still in the research phase, some therapies arising from tissue engineering endeavors have already entered the clinical setting successfully, indicating the promise regenerative medicine holds for the future.

Tissue engineering employs aspects of cell biology and transplantation, materials science, and biomedical engineering to develop biological substitutes that can restore and maintain the normal function of damaged tissues and organs. These techniques can include injection of functional cells into a nonfunctional site to stimulate regeneration and/or the use of biocompatible materials to create new tissues and organs. The 2 most basic components of tissue engineering strategies are cells and biomaterials. The introduction of cells is designed to stimulate regeneration, promote vascularization, and/or supplement the production of hormones and growth factors. Biomaterials, which include both natural and synthetic matrices ( called “scaffolds”) are important tools in regenerative medicine.

In addition to guiding the direction of new tissue growth and providing the proper spatial environment to restore tissue structure and function, biomaterials may introduce bioactive factors  or may attract cells and growth factors from the body following implantation <https://www.jpedsurg.org/article/S0022-3468(11)00883-9/fulltext>. If a biomaterial is implanted without cells, the objective is to encourage the body's natural ability to repair itself. An advantage in using native cells is that they can be obtained from the specific organ to be regenerated, expanded, and used in the same patient without rejection, in an autologous manner. (252-255)

**Muscle energy technique (MET)**

Muscle energy technique (MET) is a type of osteopathic manipulative medicine (OMM) developed by Fred Mitchell, Sr, DO, who first described the kinematic motion of the pelvis and developed a modality to treat muscular action dysfunction using the patient's muscle action. The observation that the contraction of an antagonistic muscle would help relax the agonistic muscle, led to the modality Muscle Energy, which was designed to improve musculoskeletal function by mobilizing joints and stretching tight muscles and fascia reducing pain and improving circulation and lymphatic flow.

MET can be applied in all body joints except the cranium.  MET, which is a nontraumatic modality treats key lesions that are the root cause of many dysfunctions in the body. MET involves understanding the biomechanics of the human body that can treat lesions of high velocity using less force and more precision. Dr. Mitchell's initial concept of MET involved muscle activation with post-isometric relaxation. In today's MET, there are a total of 9 different physiological principles to muscle energy:: joint mobilization using muscle force, respiratory assistance, oculocephalic reflex, reciprocal inhibition, crossed extensor reflex, isokinetic strengthening, isolytic lengthening, muscle force in one region of the body to achieve movement in another and post-isometric relaxation. Of the 9 approaches, the most utilized is post-isometric relaxation.

 MET with post-isometric relaxation is contraindicated in patients with low vitality, certain post-surgical patients, or those in the ICU. They would benefit from MET using reciprocal inhibition, respiratory assist, or the oculocephlogyric reflex. Patients with a history of eye surgery are contraindicated for MET with oculocephalogyric reflex. As the treatment requires patient cooperation, patients should be able to understand and communicate easily with the clinician. Complications can be avoided if the clinicians correctly diagnose, localize the lesions, and use appropriate force.

A comprehensive understanding of muscle physiology is essential for MET. There are 4 types of muscle contraction: isometric, concentric, eccentric, and isolytic. Isometric contraction is when the muscles contract without having the origin and insertion of the muscles approach each other. Concentric contraction is when the muscles shorten with contraction. Eccentric contraction is when the muscle lengthens with contraction, and isolytic contraction is when an external force lengthens muscle contraction. The physiology of muscle contractions best explains the mechanism of action in MET.

An inappropriate amount of force can cause tendon avulsion in geriatric patients. Rib fractures are also possible in those with osteoporosis. There have been stories of intraocular hemorrhage in a postcataract removal patient who had MET with oculocephalogyric reflex. Prioritizing precise diagnosis and localization and applying the appropriate force when using this technique is highly important. Each muscle spindle has an efferent and an afferent neural component. Motor nerve fibers are the alpha motor neurons innervating the extrafusal fibers and the gamma motor neurons innervating the intrafusal fibers.

The afferent (sensory) portions are the Ia and II fibers that innervate muscle spindles and the Ib fingers, which innervate the Golgi tendon organs at the myotendinous junction.Golgi tendon fibers play a crucial role in MET through a post-isometric relaxation mechanism. The fibers are stimulated when muscles experience heightened tension, initiating a negative feedback loop that inhibits further contraction via the Ia fibers. Understanding muscle anatomy and physiology is essential in MET. A muscle includes many spindles; each spindle comprises 3 to 12 intrafusal muscle fibers surrounded by a large extrafusal fiber.

Each spindle has an efferent and an afferent neural component. Motor nerve fibers innervate the extrafusal fibers through the alpha motor neurons, and the gamma motor neurons innervate the intrafusal fibers. The Ia and II fibers innervate the muscle spindles' afferent (sensory) portions. The central portion of a muscle spindle does not have myofibrils and does not have contracting capabilities; however, the ends of these spindles do contract in response to gamma motor neurons. The Ib fibers innervate the Golgi tendon organs (GTO) in the myotendinous junctions.<https://www.ncbi.nlm.nih.gov/books/NBK559029/> GTO is an encapsulated sensory receptor associated with 10 to 15 muscle fibers. They are stimulated to inhibit the muscle when exposed to contraction or stretching; this stimulation occurs by a negative feedback loop through the alpha neuron. When the tension on a muscle is too great, the GTO will contract to relax the entire muscle via the Ia fibers.<https://www.ncbi.nlm.nih.gov/books/NBK559029/>

The muscle is refractory after an isometric contraction, where it may be passively stretched without a reflexive contraction. In MET with post-isometric relaxation, the GTO is activated by increasing tension on the muscle fibers when the patient is asked to contract against a barrier. Once activated, there is a reflexive inhibition and relaxation of the muscle through the Ia fibers, and the clinician may further passively stretch the muscle due to the refractory state.Two reflex systems within a muscle unit play a role in MET: intrinsic and extrinsic reflex systems.

**Intrinsic Reflex System**

The basic functional unit in muscle physiology is called a myotactic unit, which includes a motor unit and the intrinsic sensory system from the muscle fibers. These sensory receptors comprise 2 types of intrafusal fibers: nuclear bag and nuclear chain (bundles together). The nuclear bag fibers extend beyond the capsule to attach to the endomysium, and the nuclear chain attaches to the inside of the capsule.<https://www.ncbi.nlm.nih.gov/books/NBK559029/> Nuclear bag receptors adapt to muscle length, velocity, and acceleration of contractions. The nuclear chain fibers slowly adapt to tension. There is a hypothesis that the alpha motor neuron is firing to contract the muscle to reduce the tension on the nuclear chain fibers in a somatic dysfunction. During MET with post-isometric relaxation, contracting the extrafusal muscles while the length of the muscle remains constant engages the nuclear bag fibers. This contracting reduces the nuclear chain, and the nuclear bag fibers quickly adapt to the stretch. The post-isometric stretch is complete without further elongating the bag fibers due to the refractory period from the decrease in gamma efferent discharge to the spindles.

**Extrinsic Reflex System**

In the extrinsic system, the alpha and gamma efferents of the muscle receive synaptic information from sensory nerves from other organs or muscles. This system includes reciprocal inhibition of antagonist muscles, pain avoidance, conditioned reflex, viscerosomatic reflexes, and muscle spasms. Before birth, the first evidence of GTOs is observable in aponeurosis, where Ib axons terminate within islets of collagen bundles and myotubules.<https://www.ncbi.nlm.nih.gov/books/NBK559029/>  In the first postnatal week, the innervated core elongates as collagen bundles and Schwann cells proliferate. Within the capsule completed by day 2, collagen fibrils are placed between the Schwann cells and the terminal nerve ends. These collagen bundles link the muscle fiber tips to the aponeurosis, establishing the relationship of muscle tension to GTO activation. Muscular contraction applies force to the collagen bundles, stimulating the nerve endings within the GTO.

Muscle spindle differentiation starts around 11 weeks of gestation when the intrafusal and extrafusal fibers differentiate. The Ia afferent axon communicates to the spindle, prompting the formation of the nuclear bag, a term given to intrafusal fibers with multiple equatorial nuclei.  Subsequently, the motor nerve supply reaches the spindle.  The spindle matures between 24 to 31 weeks and increases in length after birth.

The MET cannot directly affect organ systems, as this technique is used to treat the musculoskeletal system. However, it may affect and change certain organ system's functioning through viscerosomatic reflexes.  Each organ system in the body has sympathetic and parasympathetic innervations dependent on where the nervous innervation arises in the spinal cord: sympathetic in the thoracolumbar region and parasympathetic in the sacral and cervical regions. Problems in specific viscera present with somatic changes due to the innervation at that level called spinal facilitation that. sends increased output from the spinal cord, leading to changes in the alpha motor neuron and sympathetic outflow, causing increased pain. This facilitation can be treated using specific MET.

MET assumes that a shortened or contracted muscle maintains a somatic dysfunction. There are several hypotheses to the behaviors of such muscles: neuroreflexive (most likely), fibrosis, and congestion of muscle tissue (a cause of myofascial trigger points). MET approaches and treats the muscles using physiological principles and is not used to treat subluxations. METs take advantage of the physiologic mechanisms of post-isometric relaxation and reciprocal inhibition, primarily to improve musculoskeletal function and reduce pain. MET is "direct" or "indirect" for a given joint based on the indication.

**Post-isometric Relaxation**

Golgi tendon organs (GTOs) are mechanoreceptors in most skeletal muscles. They are sensitive to muscular contractile force, and in contrast to muscle spindles, muscle stretches rarely and inconsistently activate GTOs. These encapsulated bundles of collagen are innervated by fast-conducting type Ib afferent fibers and are present at muscle-tendon or muscle-aponeurosis junctions; they attach to an individual muscle fascicle tendon on one end, and the whole muscle-tendon or aponeurosis of the other. This positioning, described as "in-series," means the receptor is part of the functional unit and stands in contrast to the muscle spindle that operates adjacent to the functional unit "in parallel.GTOs are activated at high levels of force and hypothetically inhibit muscle activity, preventing musculoskeletal injury

Physiologically, increased tension to the GTO prompts the activation of the type Ib afferent fibers that project to the spine, where they provide positive input on inhibitory interneurons that, in turn, add negative or inhibitory input on the efferent α-motor neurons that receive input from the cortex to the homonymous muscle. In effect, sufficient GTO stimulation can override the efferent output from the brain, leading to relaxation. This phenomenon is known as the "inverse stretch" or the "autogenic" reflex. There is a refractory state after an isometric contraction where passive stretching may be performed without a myostatic reflex opposition.The patients are usually placed into the barrier and asked to contract against the clinician. They are then asked to relax. This phase is refractory, where a new barrier can be reached, and the process is repeated.

**Joint Mobilization Using Muscle Force**

A distortion of articulation and motion loss leads to reflexive hypertonicity of the muscles crossing the joint. The reflexive hypertonicity further compresses the dysfunctional joint surface and leads to the thinning of the synovial fluid layers and adherence of both joint surfaces. Treating the segment requires the maximum force the clinician can tolerate to "reseat" the joint and reflexively relax the hypertonic muscle.

**Respiratory Assists**

The clinician holds a fulcrum using the motion of the ribs or the subtle movement of the spine/pelvis during respiration, allowing the respiratory forces to work. This technique frequently treats somatic dysfunctions in the ribs and sacrum.

**Reciprocal Inhibition**

Muscle spindles are stretch-sensitive mechanoreceptors found in skeletal muscle. A muscle spindle is a bundle of striated, intrafusal muscle fibers within the fascicles of force-producing, extrafusal muscle fibers. "Fusal" derives from the term "fusiform," meaning spindle-shaped. Any stretch or change in the length of the extrafusal fibers results in a stretch of the intrafusal fibers, which is then detected in the equatorial and polar regions of the muscle spindle. This physiology stands in contrast to GTOs, which are relatively insensate to passive changes in length but respond to an increase in muscle force. Two afferents, primary (type Ia) and secondary (type II), measure the stretch sensation. A single Ia fiber is present, along with between 0 to 5 II fibers per spindle.<https://www.ncbi.nlm.nih.gov/books/NBK559029/>

The Ia fiber is comparable in size and speed of transmission to the Ib fibers and supplies all intrafusal fibers in the spindle at the equatorial region  The myelinated γ-motor neurons derive from the same efferents that supply the extrafusal muscle. Excitation of these γ-motor neurons does not affect overall muscle tension but maintain tension on the muscle spindles to track the length of the extrafusal fibers effectively. Spindle afferents are tonically active, with an increased firing rate in response to passive stretch in a velocity-dependent manner.<https://www.ncbi.nlm.nih.gov/books/NBK559029/>

Physiologically, stretch to a muscle fiber produces activation of Ia muscle spindle afferents that project to the spine and activate the efferent α-motor neurons and, subsequently, the γ-motor neurons of the homonymous muscle, leading to contraction of the intra- and extrafusal fibers. Simultaneously, the Ia fibers activate inhibitory interneurons in the spine to inhibit the α-motor neurons of the antagonist's muscle. This circuit is called the stretch reflex, believed to prevent muscle strain and support bipedal walking and posture. This principle is used when contracting the antagonist to relax the dysfunctional agonist muscle.

**Oculocephalogyric Reflex**

The oculocephalogyric reflex approach to MET can gently treat an unstable segment in the upper cervical spine using eye motion.  Nerves for the extraocular muscles are sent to the vestibular nuclei via the ophthalmic division of the trigeminal nerve. Information from the vestibular nuclei then travels down the medial and lateral vestibulospinal tract. The medial tract specifically goes to C1, which may branch into the suboccipital muscles, allowing motion within the suboccipital muscles.<https://www.ncbi.nlm.nih.gov/books/NBK559029/>  This approach is useful if the patient has severe pain in the upper cervical spine or if upper cervical instability is suspected. The patient is set up to look toward a stimulus to test the reflex.

**Crossed Extensor Reflex**

MET uses the concept of crossed extensor reflex in the extremities when muscle damage occurs. Voluntary contraction will inhibit the same contralateral muscle and activate the contralateral antagonist muscle. An example of the reflex is if one flexes their quads to lift their legs due to stepping on a nail, and the contralateral hamstring muscle contracts to help stabilize. During the signaling pathway, the efferent nerves communicate with multiple interneurons at the level of the spinal cord, where one relays the message to the contralateral agonist muscle to relax.

**Isokinetic Strengthening**

This approach to MET is to help strengthen the muscle. A concentric contraction can shorten the muscle at a controlled rate. It is advised to first treat any shortening of an antagonistic muscle before performing strengthening treatments. For example, the quadriceps may be weakened due to hypertonic/shortened hamstrings; treatment would begin with treating the shortened hamstring muscles followed by isokinetic quadriceps strengthening.

**Isolytic Lengthening**

This approach is used to lengthen a muscle shortened by contracture of fibrosis. An isolytic contraction occurs because the clinician's force overcomes the contracture of the patient. The clinician applies a vibratory motion while performing the technique, as there is anecdotal evidence that it can help break up fibrosis and circulation.

**Coordinated Motor Movement**

This approach to MET involves moving adjacent body parts to treat the somatic dysfunction. It is thought that muscle contraction during the motion of the adjacent regions affect the area of dysfunction. An example is the treatment of a bilaterally extended sacrum; the patient is asked to push the pelvis and leg to treat the sacral dysfunction. To successfully perform MET, it is imperative to have the correct diagnosis. Fryette's 3 laws of spinal mechanics are used to diagnose MET :

* In a neutral position, the segments side bend and rotate to the opposite side
* In a non-neutral spinal position, the segments side-bend and rotate in the same direction
* A motion in one plane reduces the motions in the other two planes of the spinal segment <https://www.ncbi.nlm.nih.gov/books/NBK559029/>

The increased muscle tone purportedly treated by MET is comparable to that of the hypertonicity or spasticity that presents in upper motor neuron disease. Increased activity of the extrafusal muscle fibers is secondary to either increased activity of the muscle spindle or abnormal sensory processing in the spinal cord. Increased activity of γ-motor neurons leads to abnormally shortened muscle spindles, resulting in a hyperexcitable state such that movement within the physiologic range of motion produces reflexive muscular contraction. Similarly, type II fibers are hypothesized to contribute to spasticity through direct α-motor neuron activation.

MET primarily serves to improve the range of motion and reduce pain.  These techniques are used by physicians (osteopathic and allopathic) as well as physical therapists and chiropractors for primary or adjunctive therapy MET is used to reduce pain secondary to hypertonicity in the back, neck, and other major joints. This modality may hypothetically treat nearly any joint in the body. MET, in addition to standard-of-care treatment and other osteopathic techniques, has been demonstrated to improve outcomes in conditions such as pneumonia and fibromyalgia. In these cases, the complementary effects are attributed to fascial stretching, which is proposed to improve lymphatic and hemodynamic function.

The effectiveness of MET is dependent on diagnosis, localization, and the amount of force used. Differentiating between a key lesion and a compensatory change in diagnosis is important. An example is when a somatic dysfunction at the L5 often causes a compensatory change at the sacral base Although a segmental diagnosis is identified, significant side bending restriction in the segment above actively causes fascial strain, potentially leading to treatment difficulty in the identified segmental somatic dysfunction. Using an excessive amount of force is a common mistake that is made by those new to MET.

When using excessive force, a larger group of muscles is engaged to stabilize the segment being treated. Further stability in the treated segment will negate the effects of muscle energy. Using 5 to 10 pounds of force during MET is commonly taught. However, experienced clinicians use enough force to observe a change in the relevant segment without recruiting surrounding muscles. The localization of the force is more important than the amount of force. Position the body so the force applied is on the treated segmental joint. Clinicians should make subtle changes depending on the anatomic variability between individual patients. For example, the sacrum is known to have 3 transverse axes and 2 oblique axes. The middle transverse axis is where the sacrum moves about the innominate, and the inferior transverse axis is where the innominate moves against the sacrum. A clinician treating an anterior innominate would want to flex the hip until the inferior transverse axis is engaged. Flexing too much or too little will not engage the proper joint segment and decrease the chance of successful treatment. MET with post-isometric relaxation is the most commonly used modality and entails the following steps:

1. The target joint or muscle barrier is isolated through joint positioning, to a pathologic barrier.
2. Follow with active muscle contraction by the patient in a specific direction, away from the restriction, for a specified period against clinician-applied counterforce. Conventionally, the amount of force generated by the patient should be the maximum amount comfortably tolerated by both the patient and the clinician.
3. Have the patient relaxation of the contracted muscle.
4. Use passive movement of the patient's anatomy toward a new pathologic barrier.
5. Repeat steps 1 to 4 as tolerated until physiologic pain is sufficiently relieved, or the patient achieves the desired range of motion.<https://www.ncbi.nlm.nih.gov/books/NBK559029/>

Post-isometric relaxation is the most commonly used muscle energy technique (MET) in osteopathic medicine for improving thoracic spine restriction. MET is used by osteopathic physicians as a conservative, nonpharmacological treatment method for somatic dysfunctions of the musculoskeletal system. MET is a form of manual therapy and stretching. The patient actively contracts muscles in a precise direction while the therapist provides counterforce resistance. Isometric contractions relax and lengthen muscles.

The thoracic spine consists of 12 spinal vertebrae, and holds particular significance for osteopathic physicians due to its association with sympathetic nerve fibers. Somatic dysfunctions in this region can result from biomechanical factors, such as restrictions in segments affected by surrounding muscles, or they may even have viscerosomatic origins. Thoracic vertebrae have a posterior spinous process, an anterior vertebral body, and bilateral transverse processes on each side. These vertebrae have facet joints above and below, facilitating articulation with adjacent segments. The superior facet joint in the thoracic segment is oriented in a posterior, upward, and lateral direction. Due to the presence of the ribs, thoracic vertebrae also have a superior and inferior costal facet near the vertebral body and a transverse costal facet on the transverse process. The orientation of T12's articular facet may face slightly from the other thoracic vertebrae due to its articulation with L1.<https://www.ncbi.nlm.nih.gov/books/NBK560895/>

The Rule of Threes, frequently taught in osteopathic education, aids in pinpointing the location of the spinous process concerning the transverse process. According to this rule, for T1 through T3, the spinous process aligns with the transverse process. For T4 through T6, the spinous process is positioned midway between the transverse processes of the adjacent segments. From T7 through T10, the spinous process is at the level of the next transverse process (the 7th spinous process is at the level of T8). The 11th spinous process is halfway, and the 12th spinous process is at the same level as its transverse process.

Somatic dysfunctions are categorized into 2 types. Type 1 dysfunctions involve a group of segments and often result from chronic poor posture. These dysfunctions typically affect the larger, long-supportive muscles of the back, like the erector spinae, and are usually positioned neutrally but with rotation and side bending in opposite directions. On the other hand, Type 2 dysfunctions are more acutely tender and affect the smaller supportive muscles between segments, such as the rotatores, multifidus, interspinales, and intertransversarii muscles. Type 2 dysfunctions are typically characterized by flexion or extension, side bending, and rotation in the same direction.

MET with post-isometric relaxation is indicated in somatic dysfunction as long as there are no contraindications. If a muscle is painful, it may be a better candidate for MET with reciprocal inhibition. MET with post-isometric relaxation is indicated for the treatment of somatic dysfunction in the thoracic spine resulting in, but not limited to:

* Back pain <https://www.ncbi.nlm.nih.gov/books/NBK560895/>
* Decreased range of motion <https://www.ncbi.nlm.nih.gov/books/NBK560895/>
* Respiratory dysfunction

MET with post-isometric relaxation is contraindicated in patients with an acute fracture or dislocation. Those with tissue damage to ligaments, tendons, and muscles may not be the best candidates. It is best to wait for vital stability before trying this technique. If muscle spasm is centrally mediated, patients do not respond well to MET. Patients need to be cooperative to follow the instructions required for this technique.MET with post-isometric relaxation is a hands-on osteopathic manipulative treatment that necessitates a stable, firm surface, preferably an adjustable height cushioned table for optimal treatment positioning and patient and physician comfort

After thoroughly discussing the risks, benefits, and alternative treatment options, obtaining informed patient consent is imperative for any procedure, including MET and osteopathic manipulative therapy. Before initiating physical contact with the patient, the provider should clearly explain the procedures they will perform. The treatment process commences with a comprehensive static and dynamic evaluation of the segments within the thoracic spine. Clinicians may employ soft tissue techniques as a prelude to direct techniques like MET with post-isometric relaxation, particularly when significant muscle texture changes are present. The targetted segment must be localized and isolated when treating the thoracic spine with MET. In the upper thoracic spine (T1-T4), it is common to use the head and neck as a lever. The lower thoracic spine segments (T5-T12) can be localized by manipulating the position of the patient's trunk. Localizing the dysfunctional segment involves monitoring the posterior transverse process for motion throughout the treatment through palpation. Post-isometric relaxation is the type of MET most commonly used. The patient is placed into the barrier and asked to resist motion toward freedom.

Patients undergoing MET with post-isometric relaxation treatment should understand they may experience muscle soreness and fatigue after treatment. The clinician may suggest increasing water intake following treatment. Excessive force can result in complications such as tendon avulsion or rib fracture. To mitigate the force in post-isometric relaxation, the patient must be asked to resist just enough to engage the treated segment.

Somatic dysfunction of the thoracic spine commonly results in back pain and discomfort, causing patients to seek medical advice. Osteopathic techniques, including MET, provide a conservative, nonpharmacological avenue for alleviating pain and correcting musculoskeletal somatic dysfunctions in the thoracic spine, leading to an increased range of motion in affected joints. MET with post-isometric relaxation creates necessary soft tissue relaxation to help with high-velocity, low-amplitude techniques. MET can also help resolve hypertonic tissue before myofascial release techniques. The basic concepts of MET involve using the intrinsic power of muscles to achieve a variety of effects, involving isometric and isotonic contraction variations, and this volume aims to offer insights into, and practical applications of, most of these.Proprioceptive neuromuscular facilitation (PNF) variations (including hold–relax and contract–relax) involve stretching which is either passive or passive-assisted, following a strong contraction.

In active isolated stretching (AIS) , in which Flexibility is encouraged , uses active stretching by the patient and reciprocal inhibition (RI) mechanisms. AIS, unlike MET (which combines RI and PIR as well as active patient participation), does not utilise the benefits of postisometric relaxation (PIR).

In AIS:

1. The muscle needing stretching is identified.

2. Precise localisation should be used to ensure that the muscle receives specific stretching.

3. Use should be made of a contractile effort to produce relaxation of the muscles involved.

4. Repetitive, fairly short duration, isotonic muscle contractions are used to increase local blood flow and oxygenation.

5. A synchronised breathing rhythm is established, using inhalation as the part returns to the starting position (the ‘rest’ phase) and exhalation as the muscle is taken to, and through, its resistance barrier (the ‘work’ phase).

6. The muscle to be stretched is taken into stretch just beyond a point of light irritation – with the patient’s assistance – and held for 1–2 seconds before being returned to the starting position.

7. Repetitions continue until adequate gain has been achieved.

**Yoga stretching (and static stretching)**

Adopting and maintaining specific postures based on traditional yoga for some minutes at a time (combined, as a rule, with deep relaxation breathing) allows a slow release of contracted and tense tissues to take place. A form of self-induced viscoelastic myofascial release takes place as tissues are held, unforced, at their resistance barrier. Yoga stretching, applied carefully, after appropriate instruction, represents an excellent means of home care. There are superficial similarities between yoga stretching and static stretching . While Anderson, stretching is maintained at the barrier for short periods (usually no more than 30 seconds) before moving to a new barrier, . a series of rapid, ‘bouncing’, stretching movements are the key feature of ballistic stretching.

Postisometric relaxation (PIR) (the latent hypotonic state of a muscle following isometric activity) refers to the effect of the subsequent reduction in tone experienced by a muscle, or group of muscles, after brief periods during which an isometric contraction has been performed. The terms proprioceptive neuromuscular facilitation (PNF) represent another variation as well as isometrically contracted – reciprocal inhibition (RI).variation involving the physiological response of the antagonists of a muscle. When a muscle is isometrically contracted, its antagonist is inhibited, and demonstrates reduced tone immediately The antagonist of a shortened muscle, or group of muscles, may be isometrically contracted in order to achieve a degree of ease and additional movement potential in the shortened tissues. Reciprocal inhibition variation method, which forms a component of PNF methodology and MET, is mainly used in acute settings, where tissue damage or pain precludes the use of the more usual agonist contraction

1. The affected muscle is placed in a mid-range position.

2. The patient is asked to push firmly towards the restriction barrier and the operator either completely resists this effort (isometric) or allows a movement towards it (isotonic). Some degree of rotational or diagonal movement may be incorporated into the procedure.

3. On ceasing the effort, the patient inhales and exhales fully, at which time the muscle is passively lengthened.

The essence of MET is using the energy of the patient, that may be employed in one or other of the manners with any combination of variables depending upon the particular needs of the case. The use of eye movements as part of the methodology indicates, that flexion is enhanced by the patient looking downwards, and extension by the patient looking upwards. Similarly, sidebending is facilitated by looking towards the side involved. These ideas are easily proved by self-experiment: an attempt to flex the spine while maintaining the eyes in an upwards (towards the forehead) looking direction will be found to be less successful than an attempt made to flex while looking downwards. These eye-direction aids are also useful in manipulation of the joints.

Another major muscle energy variation is to use isokinetic contraction ( known as progressive resisted exercise). Isolytic MET , another application of the use of isotonic contraction occurs when a direct contraction is resisted and overcome by the operator. This isolytic contraction, involves the stretching, and the breaking down, the fibrotic tissue present in the affected muscles. Adhesions of this type are reduced by the application of force by the operator which is just greater than that being exerted by the patient. This procedure can be uncomfortable, and the patient should be advised of this. Limited degrees of effort are therefore called for at the outset of isolytic contractions. This is an isotonic eccentric contraction, in that the origins and insertions of the muscles involved will become further separated, despite the patient’s effort to approximate them. In order to achieve the greatest degree of stretch (in the condition of myofascial fibrosis, for example), it is necessary for the largest number of fibres possible to be involved in the isotonic contraction. in order to achieve this large involvement, the degree of contraction should be a maximal one, and yet this is likely to produce pain, which is contraindicated. in many instances, it may be impossible for the operator to overcome.

The patient should be instructed to use about 20% of possible strength on the first contraction, which is resisted and overcome by the operator, in a contraction lasting 3–4 seconds. This is then repeated, but with an increased degree of effort on the part of the patient (assuming the first effort was relatively painless). This continuing increase in the amount of force employed in the contracting musculature may be continued until,, a maximum contraction effort is possible, again to be overcome by the operator. In some muscles, this may require a heroic degree of effort on the part of the operator, and alternative methods are therefore desirable. Deep tissue techniques, such as neuromuscular technique, seem to offer such an alternative. The isolytic manoeuvre should have as its ultimate aim a fully relaxed muscle, although this will not always be possible. The restriction which takes place as a result of tight, shortened muscles is usually accompanied by some degree of lengthening and weakening of the antagonists. A wide variety of possible permutations exists in any given condition involving muscular shortening which may be initiating, or be secondary to, joint dysfunction combined with weakness of antagonists.

A combination of isometric and isotonic methods can effectively be employed to lengthen and stretch the shortened groups, and to strengthen and shorten the weak, overlong muscles.all-active, with many variables in between Such alignment changes produce weight-bearing stresses on joint surfaces, and result also in shortened soft tissues chronically contracting over time. Such imbalances result in reduced segmental control with chain reactions of compensation emerging Most musculoskeletal dysfunction can be shown to emerge out of adaptive processes, as the body – or part of it – compensates for what is being demanded of it in its daily activities.

As a rule the adaptive demands relate to a combination of processes, repetitive use patterns, postural habits, emotional turmoil, chronic changes (e.g. arthritic) and so on. Onto such evolving patterns sudden blows and strains are all too often superimposed, adding new demands and directions to the adaptive efforts of the body. The bodies compensate (often without obvious symptoms) until the adaptive capacities of tissues are exhausted, at which time decompensation begins, and symptoms become apparent: pain, restriction, limitation of range of movement, etc. The processes of decompensation then progress towards chronic dysfunction and possibly disability. Nociceptive responses (which are more powerful than proprioceptive influences) would occur, and these multisegmental reflexes would produce a flexor withdrawal – increasing tone in the flexor muscles. Where pain is a factor in strain this has to be considered as producing an overriding influence over whatever other more ‘normal’ (proprioceptive) reflexes might be operating.

When stressful forces (either undesirable or therapeutic) are applied to fascia, there is a first reaction in which a degree of slack is allowed to be taken up, followed by what is colloquially referred to as ‘creep’ – a variable degree of resistance (depending upon the state of the tissues). ‘Creep’ is an honest term which accurately describes the slow, delayed yet continuous stretch which occurs in response to a continuously applied load, as long as this is gentle enough to not provoke the resistance of colloidal ‘drag’. This highlights the absolute need in applying MET for stretching to be slow and gentle, involving ‘taking out of slack’, followed by stretch at the pace the tissues allow, unforced, if a defensive response is to be avoided. Since the fascia comprises a single structure, the implications for body-wide repercussions of distortions in that structure are clear.

An example of one possible negative influence of this sort is to be found in the fascial divisions within the cranium, the tentorium cerebelli and falx cerebri which are commonly warped during birthing difficulties (too long or too short a time in the birth canal, forceps delivery, etc.) and which are noted in craniosacral therapy as affecting total body mechanics via their influence Such changes are not, permanent since collagen (the raw material of fascia/connective tissue) has a limited (300–500 day) half-life and, just as bone adapts to stresses imposed upon it, so will fascia.

If, negative stresses (posture, use, etc.) are modified for the better and/or positive ‘stresses’ are imposed – manipulation and/or exercise for example – dysfunctional connective tissue can usually be improved over time ).on fascia . There are four crossover sites where fascial tensions can be noted: occipitoatlantal (OA), cervicothoracic (CT), thoracolumbar (TL), lumbosacral (LS). These sites are tested for their rotation and sidebending preferences.the musculature) throughout the body .Pain is more associated with tight and bound/tethered structures, which may be due to local overuse/misuse/abuse factors, to scar tissue, to reflexively induced influences, or to centrally mediated neural control. When a tight tissue is asked to either fully contract or fully lengthen, pain is often experienced.

The normal response of muscle to any form of stress is to increase in tone The stress factors which negatively influence musculoskeletal soft tissues structure lead to musculoskeletal dysfunction Acquired postural imbalances ‘Pattern of use’ stress (occupational, recreational, etc.) Inborn imbalance such as (short leg, short upper extremity, small hemipelvis, fascial distortion via birth injury, etc.)

The effects of hyper- or hypomobile joints, including arthritic changes

Repetitive strain from hobby, recreation, sport, etc. (overuse)

Emotional stress factors

Trauma (abuse),

inflammation and subsequent fibrosis

Disuse,

immobilisation

Reflexogenic influences (viscerosomatic, myofascial and other reflex inputs)

Climatic stress such as chilling

Nutritional imbalances (vitamin C deficiency reduces collagen efficiency for example)

Infection producing irritation,

increased muscle tension and pain,

A chain reaction will evolve as any one, or combination of, the stress factors , or additional stress factors, cumulatively demand increased muscular tone in those structures obliged to compensate for, or adapt to them, resulting in the following events:

The muscles antagonistic to the hypertonic muscles become weaker (inhibited) – as may the hypertonic muscles themselves.

The stressed muscles develop areas of relative hypoxia and ultimately ischaemia while, simultaneously, there will be a reduction in the efficiency with which metabolic wastes are removed.

The combined effect of toxic build-up (largely the by-products of the tissues themselves) and oxygen deprivation leads to irritation, sensitivity and pain, which feeds back into the loop, so creating more hypertonicity and pain. This feedback loop becomes selfperpetuating. Oedema may also be a part of the response of the soft tissues to stress. If inflammation is part of the process, fibrotic changes in connective tissue may follow. Neural structures in the area may become facilitated, and therefore hyper-reactive to stimuli, further adding to the imbalance and dysfunction of the region .

Initially, the soft tissues involved will show a reflex resistance to stretch and after some weeks a degree of fibrous infiltration may appear as the tissues under greatest stress mechanically, and via oxygen lack, adapt to the situation. The tendons and insertions of the hypertonic muscles will also become stressed and pain and localised changes will begin to manifest in these regions. Tendon pain and periosteal discomfort are noted . If any of the hypertonic structures cross joints, become crowded and some degree of imbalance will manifest as abnormal movement patterns evolve (with antagonistic and synergistically related muscles being excessively hypertonic and/or hypotonic, ), leading ultimately to joint dysfunction.

Localised reflexively active structures (trigger points) will emerge in the highly stressed, most ischaemic, tissues, and these will themselves become responsible for the development of new dysfunction at distant target sites, typically inhibiting antagonist muscles . Because of excessive hypertonic activity there will be energy wastage and a tendency to fatigue – both locally and generally Functional imbalances will occur, involving respiration, when chain reactions of hypertonicity and weakness impact on this vital function Muscles will become involved in ‘chain reactions’ of dysfunction.

A process develops in which some muscles will be used inappropriately as they learn to compensate for other structures which are weak or restricted, leading to adaptive movements, and loss of the ability to act synergistically as in normal situations Over time, the central nervous system learns to accept altered pattepatterns of use as normal, adding further to the complication of recovery since rehabilitation will now demand a relearning process as well as the more obvious structural (shortness) and functional (inhibition/weakness) corrections

Ligaments and muscles which are hypermobile do not adequately protect joints and therefore fail to prevent excessive ranges of motion from being explored. Without this stability, overuse and injury stresses evolve and muscular overuse is inevitable. The muscles which shorten are those which have a primarily postural rather than phasic (active, moving) role and it is possible to learn to conduct, in a short space of time (10 minutes or so) an assessment sequence in which the majority of these can be identified as being either short or relatively ‘normal’ Patterns of imbalance can be observed in predictable areas, relating to specific forms of dysfunction (headache, thoracic inlet, low back, etc.).

If an imbalance pattern is recognisable, and, within that, emphasis is given to what is hypertonic and what (within both hypertonic and hypotonic muscles) is reflexively active, as in the case of myofascial trigger points, a therapeutic starting point is possible which leads physiologically towards the normalisation and resolution – if only partially – of the somatic dysfunction patterns currently on display. As whatever is tense and tight to an undesirable degree is released and stretched, so will antagonists regain tone, and a degree of balance be restored. As local myofascial trigger areas are resolved, so will reflexively initiated pain and sympathetic overactivity be minimised. The stress burden will be lightened, energy will be saved, function will improve, joint stress will be reduced, exacerbation of patterns of dysfunction will be modified.relatively ‘normal’ The reflex patterns – and facilitation In the body, when an area is stressed repetitively and chronically, the local nerve structures in that area tend to become overexcitable, more easily activated, hyperirritable – a process known as facilitation.

Segmental facilitation: Organ dysfunction will result in facilitation of the paraspinal structures at the level of the nerve supply to that organ. If there is any form of cardiac disease, , there will be a ‘feedback’ of impulses along these same nerves towards the spine, and the muscles alongside the spine at that upper thoracic level will become hypertonic. If the cardiac problem continues, the area will become facilitated, with the nerves of the area, including those passing to the heart, becoming hyperirritableOnce facilitated, if there were any additional stress impacting the individual, of any sort, whether emotional physical, chemical, climatic, mechanical or whatever, or absolutely anything which imposed stress on the person as a whole – not just this particular part of their body – there would be a marked increase in neural activity in the facilitated area and not in the rest of the spinal structures

In assessing and treating somatic dysfunction, the phenomenon of segmental facilitation needs to be borne in mind since the causes and treatment of these frequently lie outside the scope of practice of manual practitioners and therapists. In many instances, however, appropriate manipulative treatment, including use of MET, can help to ‘de-stress’ facilitated areas.A similar process of facilitation occurs when particularly easily stressed parts of muscle (origins and insertions for example) are overused, abused, misused, disused in any of the many ways Localised areas of hypertonicity will develop, sometimes accompanied by some oedema, sometimes with a stringy feel – but always with a sensitivity to pressure.

Many of the palpably painful, tender, sensitive, localised, facilitated points are myofascial trigger points which are not only painful themselves when pressed, transmit or activate pain (and other) sensations some distance away from themselves, in ‘target’ tissues. In the same manner as the facilitated areas alongside the spine, these trigger points will be made more active by any stress, of whatever type, impacting on the body as a whole – not just on the area in which they lie. When not actively sending pain to a distant area, trigger points (local tender or pain areas) are said to be ‘latent’. The same signs as described for spinal/segmental facilitation can be observed and palpated in these areas, with ‘drag’ palpation being among the most rapid means of identifying such local dysfunction.Trigger points are certainly part – in some cases the major part – of the pain suffered by people with muscle pain , MET offers a useful means of treatment, since a trigger point will reactivate if the muscle in which it lies cannot easily reach its normal resting length

The concept and reality of tissues providing the palpating hands or fingers with a sense of their relative tension or ‘bind’, as opposed to their state of relaxation or ‘ease’, is one which the beginner needs to grasp and the advanced practitioner probably takes for granted.

Muscle energy technique of variations:

1. Isometric contraction – using reciprocal inhibition (acute setting, without stretching)

Indications :

Relaxing acute muscular spasm or contraction

Mobilising restricted joints

Preparing joint for manipulation.

Contraction starting point:For acute muscle or any joint problem, commence at ‘easy’ restriction barrier (first sign of resistance).

Modus operandi: Antagonist(s) to affected muscle(s) is used in isometric contraction, so obliging shortened muscles to relax via reciprocal inhibition. Patient is attempting to push towards the barrier of restriction against practitioner/ therapist’s precisely matched counterforce.

Forces : Practitioner/therapist’s and patient’s forces are matched. Initial effort involves approximately 20% of patient’s strength (or less); an increase to no more than 50% on subsequent contractions if appropriate. Increasing the duration of the contraction (up to 20 seconds) may be more effective than any increase in force.

Duration of contraction: Initially 7–10 seconds, increasing to up to 20 seconds in subsequent contractions if greater effect required, and if no pain is induced by the effort.

Action following contraction: Area (muscle/joint) is taken to its new restriction barrier without stretch after ensuring complete relaxation. Perform movement to new barrier on an exhalation.

Repetitions :Repeat three to five times or until no further gain in range of motion is possible.

2. Isometric contraction – using postisometric relaxation (acute setting, without stretching)

Indications:

Relaxing acute muscular spasm or contraction

Mobilising restricted joints

Preparing joint for manipulation.

Contraction starting point :At resistance barrier.

Modus operandi :The affected muscles (agonists) are used in the isometric contraction, therefore the shortened muscles subsequently relax via postisometric relaxation. If there is pain on contraction this method is contraindicated and the previous method (use of antagonist) is employed. Practitioner/therapist is attempting to push towards the barrier of restriction against the patient’s precisely matched counter-effort.

Forces: Practitioner/therapist’s and patient’s forces are matched. Initial effort involves approximately 20% of patient’s strength; an increase to no more than 50% on subsequent contractions is appropriate. Increase of the duration of the contraction (up to 20 seconds) may be more effective than any increase in force.

Duration of contraction: Initially 7–10 seconds, increasing to up to 20 seconds in subsequent contractions if greater effect required

Action following contraction: Area (muscle/joint) is taken to its new restriction barrier without stretch after ensuring patient has completely relaxed. Perform movement to new barrier on an exhalation.

Repetitions: Repeat three to five times or until no further gain in range of motion is possible.

1. Isometric contraction – using postisometric relaxation (chronic setting, with stretching, also known as postfacilitation stretching)

Indications: Stretching chronic or subacute restricted, fibrotic, contracted soft tissues (fascia, muscle) or tissues housing active myofascial trigger points.

Contraction starting point: Short of resistance barrier.

Modus operandi: Affected muscles (agonists) are used in the isometric contraction, therefore the shortened muscles subsequently relax via postisometric relaxation, allowing an easier stretch to be performed. Practitioner/therapist is attempting to push through barrier of restriction against the patient’s precisely matched counter-effort.

Forces: Practitioner/therapist’s and patient’s forces are matched. Initial effort involves approximately 30% of patient’s strength; an increase to no more than 50% on subsequent contractions is appropriate. Increase of the duration of the contraction (up to 20 seconds) may be more effective than any increase in force.

Duration of contraction: Initially 7–10 seconds, increasing to up to 20 seconds in subsequent contractions if greater effect required. Action following contraction Rest period of 5 seconds or so, to ensure complete relaxation before commencing the stretch, is useful. On an exhalation the area (muscle) is taken to its new restriction barrier and a small degree beyond, painlessly, and held in this position for at least 10 and up to 60 seconds. The patient should, if possible, participate in helping move the area to and through the barrier, effectively further inhibiting the structure being stretched and retarding the likelihood of a myotatic stretch reflex.

Repetitions: Repeat three to five times or until no further gain in range of motion is possible, with each isometric contraction commencing from a position short of the barrier

1. Isometric contraction – using reciprocal inhibition (chronic setting, with stretching)

Indications: Stretching chronic or subacute restricted, fibrotic, contracted soft tissues (fascia, muscle) or tissues housing active myofascial trigger points. This approach is chosen if contraction of the agonist is contraindicated because of pain.

Contraction starting point: A little short of resistance barrier.

Modus operandi: Antagonist(s) to affected muscles are used in the isometric contraction, therefore the shortened muscles subsequently relax via reciprocal inhibition, allowing an easier stretch to be performed. Patient is attempting to push through barrier of restriction against the practitioner/therapist’s precisely matched counter-effort.

Forces: Practitioner/therapist’s and patient’s forces are matched. Initial effort involves approximately 30% of patient’s strength; an increase to no more than 50% on subsequentcontractions is appropriate. Increase of the duration of the contraction (up to 20 seconds) may be more effective than any increase in force.

Duration of contraction: Initially 7–10 seconds, increasing to up to 20 seconds in subsequent contractions if greater effect required.

Action following contraction: Rest period of 5 seconds or so, to ensure complete relaxation beforecommencing the stretch, is useful. On an exhalation the area (muscle) is taken to its new restriction barrier and a small degree beyond, painlessly, and held in this position for at least 10 and up to 60 seconds. The patient should, if possible, participate in helping move the area to and through the barrier, effectively further inhibiting the structure being stretched and retarding the likelihood of a myotatic stretch reflex.

Repetitions : Repeat three to five times or until no further gain in range of motion is possible, with each isometric contraction commencing from a position short of the barrier.

1. Isotonic concentric contraction (for toning or rehabilitation)

Indications: Toning weakened musculature.

Contraction starting point: In a mid-range easy position.

Modus operandi :The contracting muscle is allowed to do so, with some (constant) resistance from

the practitioner/therapist.

Forces: The patient’s effort overcomes that of the practitioner/therapist since patient’s force is greater than practitioner/therapist resistance. Patient uses maximal effort available, but force is buil slowly not via sudden effort. Practitioner/ therapist maintains a constant degree of resistance.

Duration: 3–4 seconds.

Repetitions: Repeat five to seven times, or more if appropriate

1. Isotonic eccentric contraction (isolytic, for reduction of fibrotic change, to introduce controlled microtrauma)

Indications : Strengthening weakened postural muscle.

Contraction starting point: At restriction barrier.

Modus operandi : The muscle to be stretched is contracted and is rapidly prevented from doing so by the practitioner/therapist, via superior practitioner/therapist effort, and the contraction is overcome and reversed so that a contracting muscle is stretched. The process should take no more than 4 seconds. Origin and insertion do not approximate. Muscle is stretched to, or as close as possible to, full physiological resting length.

Forces Practitioner/therapist’s force is greater than patient’s. Less than maximal patient’s force is employed at first. Subsequent contractions build towards this, if discomfort is not excessive.

Duration of contraction 2–4 seconds.

Repetitions Repeat three to five times if discomfort is not excessive.

CAUTION: Avoid using isotonic eccentric contractions on head/neck muscles or at all if patient is frail, very pain-sensitive, or osteoporotic.

1. Isotonic eccentric contraction (isolytic, for strengthening weak postural muscles)

Indications: Strengthening weakened postural muscle.

Contraction starting point: At restriction barrier.

Modus operandi: The muscle is contracted and is prevented from doing so by the practitioner/ therapist, via superior practitioner/therapist effort, and the contraction is slowly overcome and reversed, so that a contracting muscle is stretched. Origin and insertion do not approximate. Muscle is stretched to, or as close as possible to, full physiological resting length.

Forces: Practitioner/therapist’s force is greater than patient’s. Less than maximal patient’s force is employed at first. Subsequent contractions build towards this, if discomfort is not excessive.

Duration of contraction: 5–7 seconds.

Repetitions: Repeat three to five times if discomfort is not excessive.

CAUTION: Avoid using isotonic eccentric contractions on head/neck muscles or at all if patient is

frail, very pain-sensitive, or osteoporotic.

8. Isokinetic (combined isotonic and isometric contractions)

Indications: Toning weakened musculature

Building strength in all muscles involved in particular joint function

Training and balancing effect on muscle fibres.

Starting point of contraction: Easy mid-range position.

Modus operandi: Patient resists with moderate and variable effort at first, progressing to maximaleffort subsequently, as practitioner/ therapist puts joint rapidly through as full a range of movements as possible. This approach differs from a simple isotonic exercise by virtue of whole ranges of motion, rather than single motions being involved, and because resistance varies, progressively increasing as the procedure progresses.

Forces: Practitioner/therapist’s force overcomes patient’s effort to prevent movement. First movements (taking an ankle, say, into all its directions of motion) involve moderate force, progressing to full force subsequently. An alternative is to have the practitioner/therapist (ormachine) resist the patient’s effort to make all the movements.

Duration of contraction: Up to 4 seconds.

Repetitions : Repeat two to four times

Restoration of a more normal function demands the availability of therapeutic tools by means of which change can be engineered. Accompanying biomechanical (manipulation, etc.) solutions and strategies which retard the chances of recurrence should be introduced, possibly involving particular focus on key muscles requiring strengthening, or enhanced posture, or breathing function. Such ‘reeducation’ depends for success at least partly on the structural and functional imbalances which are present at the outset being modified to allow change (towards improved posture, fuller breathing, etc.). No one with restricted and shortened accessory breathing/upper fixator muscles can learn to breathe correctly until these have been to an extent normalised. No one with short lumbar erector spinae and weak abdominal muscles can learn to use their spine in a posturally correct manner until these muscular imbalances have been to an extent normalised. The structure–function continuum demands that therapeutic attention be paid to both aspects. Function cannot change until structure allows it to do so, and structure will continue to modify and adapt at the expense of optimal function until dysfunctional patterns of use change.

Part of a solution is offered by the methods used in muscle energy technique (MET), in which the short and tight structures are identified and lengthened while the weak and ‘sagging’ muscles are encouraged to enhanced tone and strength. Rehabilitation and re-education methods can then work in a relatively unhindered environment as new habits of use are learned.In a chronic condition, when stretching beyond the initial resistance barrier is introduced following an isometric contraction, the objective is clearly to lengthen the shortened structure being treated. Application of MET comprises neurological as well as biomechanical elements.The isometric contraction involves two neurological components: Postisometric relaxation (PIR) will follow contraction of the agonist, as a result of Golgi tendon organ mediation Reciprocal inhibition (RI) will occur affecting the antagonist, as a result of spindle mediation. Reciprocal inhibition is again a feature when the patient actively assists an area into stretch, so reducing the likelihood of the myotatic stretch reflex being activated, while at the same time reciprocally inhibiting the tissues which are being taken past their restriction barrier.

Once stretching has actually commenced, biomechanical effects are initiated as sustained, low intensity force is applied to lengthen the tissues and ‘creep’ begins. The longer the stretched status is maintained, the greater the viscoelastic effect on connective tissue and the more ‘permanent’ the increased length is likely to be .When treating restricted joints using MET no stretching should be introduced following isometric contractions. The MET approach suggested is precisely that indicated for acute soft tissue problems. The barrier is engaged and, following isometric contraction, a new barrier is moved to, without force or stretching. Unlike the time required to hold soft tissues at stretch in order to achieve a lengthening, no such feature is part of the protocol for treatment of joints using MET. Once the new barrier is reached, having taken out available slack without force after the isometric contraction, the subsequent contraction is called for and the process is repeated.

Proprioceptive neuromuscular facilitation (PNF) was originally utilised for neuromuscular reeducation in stroke victims and later it was discovered that it was clinically useful in rehabilitating children with cerebral palsy (CP) This led to its use for a wide range of orthopaedic conditions. PNF is a philosophy of care which treats the whole body by stimulation of basic movement patterns These patterns are of neurodevelopmental origin and are incorporated in functional activities such as swimming, running, climbing, throwing, etc. Therefore, in contrast to most isotonic training approaches which are uniplanar, PNF methods resist movement in multiple planes simultaneously. For instance, a diagonal pattern of movement will be resisted at the same time as a flexion/extension and abduction/adduction of an extremity.

A wide variety of treatment methods have been advocated in treating trigger points, including inhibitory (ischaemic compression) pressure methods , acupuncture and/or ultrasound chilling and stretching of the muscle in which the trigger lies , procaine or Xylocaine injections active or passive stretching and even surgical excision . Clinical experience has shown that while all or any of these methods can successfully inhibit trigger point activity short-term, in order to completely eliminate the noxious activity of the structure, more is often needed. Muscle energy techniques are applied to reduce pain and increase range of motion. These are applied to a variety of pathological conditions and on asymptomatic subjects. (256-259)

**Kinesiology**

Kinesiology is a diagnostic, therapeutic complementary therapy utilising subtle change in manual muscle testing results to evaluate the body's energetic balance and select healing modalities.The term ‘kinesiology’ , which is used in referring to the science of human movement including physiotherapy, a specific therapeutic tool used in physiotherapy practice (kinesiology taping), and the ‘applied kinesiology’ techniques, used by chiropractors, is the study of human motion and deals mainly with the muscles and muscle functions. It describes movement, which muscles are involved in the movement, and how they are involved. It explores the muscular involvement in strength exercises and sports technique.

The Greek words ‘Kinetin’- to Move, ‘Logos’- to Study so it is the scientific study of movements. Kinesiology is the multi-disciplinary study of human movement, broadly encompassing topics in biophysical (e.g., anatomy, physiology, biomechanics, and motor learning), behavioural (e.g., sports and health psychology), and sociocultural (e.g., sports humanities, sociology, and philosophy) domains.

Biomechanics is a fundamental component of Kinesiology, offering critical insights into the mechanics of human movement. Centre of gravity (COG)is the point in a body or system around which its mass or weight is evenly distributed or balanced and through which the force of gravity acts. The Centre of gravity is fixed, provided the size and shape of the body do not change. The anatomical position of the COG is approximately anterior to the second sacral vertebra.

Since human beings do not remain fixed in the anatomical position, the precise location of the COG changes constantly with every new position of the body and limbs. The bodily proportions of the individual affect also the location of the COG. The body has moving parts (arms, legs, head, various areas of the trunk), at every move the shape of the overall form changes. This point can and does change based on what the body carries an extra and how it is carried , as well as the position the body takes and the movements, it means all the posture (how the body is held).

There are two types:

 Dynamic posture is how you hold yourself when you are moving, like when you are walking, running, or bending over to pick up something.

 Static posture is how you hold yourself when you are not moving, like when you are sitting, standing, or sleeping.

It is important to make sure that you have good dynamic and static posture. The key to good posture is the position of your spine.

The spine has three natural curves - at your neck, mid back, and low back. Correct posture should maintain these curves, but not increase them. The head should be above the shoulders, and the top of the shoulder should be over the hips.

Structural Kinesiology is a term being used to differentiate between the University program of Kinesiology and the historical background of Kinesiology found in the Chiropractic realm of study, and later referred to as Applied Kinesiology. Structural Kinesiology studies the “physiological, biomechanical, and psychological mechanisms of movement,” with a combination of techniques that assess the structural integrity of the movement, the strength and flexibility of the motion, as well as the sport psychology influences as studied in the behavioral and cognitive sciences.

Although there are many aspects of Structural Kinesiology that parallel with Energy Kinesiology, there is an amount of observation and experience that the Structural Kinesiologist relies on to make their recommendations and set up their symptom prepared protocols. This subjective approach combined with their physical assessment of the situation appears to embrace all aspects of body, mind and spirit as a full approach to care, but the subjective determination is only as valid as the knowledge obtained or discovered by the clinician.

Specialised or energy kinesiology is a non-invasive holistic therapy that delves into the intricate connection between the body's energy systems and overall well-being using manual muscle testing to assess imbalances blockages, and areas of focus. expressed in the body for holistic healing. Drawing on the test responses, kinesiologists select individualised healing components from a wide variety of tools or modalities to facilitate the natural healing process. Energetic kinesiology is based on the concept that the body's energy flows in specific patterns and pathways, influencing physical, emotional, and mental health. It integrates elements from traditional Chinese medicine, chiropractic principles, and modern holistic healing techniques. Central to this approach is the belief that the body has innate wisdom and the ability to heal itself when energy flow is balanced and unobstructed. Touch for health (TFH) based [kinesiology](https://www.sciencedirect.com/topics/medicine-and-dentistry/kinesiology) is a complementary therapy with foundations in a natural health training developed utilizing techniques from  [chiropractic](https://www.sciencedirect.com/topics/medicine-and-dentistry/chiropractic), [osteopathy](https://www.sciencedirect.com/topics/medicine-and-dentistry/osteopathic-medicine) and [acupressure](https://www.sciencedirect.com/topics/nursing-and-health-professions/acupressure) therapies. (260-266)

### Authentic Panchakarma

Ayurveda is an ancient healing science that has comprehensive teachings on preserving and maintaining physical and mental health for complete wellbeing. Panchakarma, Ayurveda’s five-step traditional detoxification process offers the ultimate mind-body healing experience by strengthening and restoring the body and balancing the three doshas- Vata, Pitta and Kapha. The five-step Panchakarma program include Vamana (emesis), Virechana (purgation), Vasti (enema), Nasya (nasal administration) and Rakta Mokshana (blood-letting). The benefits of Panchakarma include cleansing of the body, elimination of toxins, opening up of blocked channels, improving strength of digestive fire, speeding up metabolism, reducing weight, relaxing the mind and boosting immunity. When the doshic balance is disturbed it creates disorder resulting in disease.

Panchakarma is is an Ayurvedic method of treatment program for the body, mind, and consciousness that cleanses the body of unwanted waste and rejuvenates and done individually for each person with his/her specific constitution and disorder in mind. Treatment starts with pre-purification Measures of Snehan and Svedana, and then cleansing methods – Shodanas, are applied. Panchakarma therapies are a method of removing toxins from the body after lubricating it through five purification procedures to cleanse and detox the body for mental and physical wellbeing. Panchakarma is an ayurvedic treatment.

The word panchakarma is derived from two words; pancha which means five while karma means procedures and is a five-stage treatment that includes curative, preventive and promotive actions for various diseases. Panchakarma therapy is a type of detoxification program that uses different Ayurvedic cleansing and rejuvenation procedures. **Panchakarma**is a transformative therapy that detoxifies and rejuvenates the body, mind, and soul.

Panchakarma is an Ayurvedic therapy that involves Pancha (five) karmas (actions) that helps in cleansing the body of accumulated toxins with an aim to restore health. The panchakarma program consists of five cleansing and healing therapies that cleanse the body and restore doshic balance strengthen the immune system.for optimal health.

Basti Treatment used herbal enemas to purge the large intestines

* **What it is:** Administering medicinal preparations by means of enema employing herbal oils or decoctions for the purpose of cleaning the colon.
* **Benefits:** It helps in treating conditions such as chronic constipation, arthritis, and other neurological disorders.
* **How it works:** Plant extracts or liquid herbs are injected via the rectum for the purpose of tuning Vata dosha, eliminating harmful substances, and replenishing the inner organs. It also helps digestion by improving the intestines.
* Nasya Treatment is the method used to clean the nasal passage
* **What it is:** Application of medicine using the nose, for instance, to clear the nose or keep the air passage.
* **Benefits:** Sinusitis, migraine, and any non-normal breathing are less difficult to manage for the patients.
* **How it works:** Cleansing the throat area with Olea essence by nasal route removes phlegm and toxins from the head. This treatment helps in enhancing the clarity of the mind and is useful in playing a balancing role in the Kapha dosa.
* Vamana Therapy (Therapeutic Vomiting removes toxins in the stomach through therapeutic vomiting)
* **What it is:** Induced vomiting to expel toxins from the stomach and upper intestines.
* **Benefits:** That’s fantastic for curing asthma, chronic colds, and skin problems.
* **How it works:** Patients ingest medicinal liquids such as ghee or oil to induce vomiting. This treatment equalizes Kapha dosha and eliminates congestion.
* Virechana Treatment (Purgation Therapy removes toxins from the small intestines)
* **What it is:** Purgation therapy to cleanse the intestines and remove toxins from the lower intestines.
* **Benefits:** Effective for treating skin diseases, hyperacidity, and digestive disorders.
* **How it works:** Patients are given herbal laxatives or decoctions to promote bowel movements, clear excess Pitta dosha, and restore digestive health.
* Raktamokshana (Bloodletting purifies the blood with carefully controlled letting of small quantities of blood)

**What it is:** The process of cleansing the blood to remove toxins and impurities.

* **Benefits:** Treats skin disorders, hypertension, and other blood-related ailments.
* **How it works:**Techniques such as bloodletting (leech therapy) or controlled bloodletting are used to purify the blood and balance Pitta dosha

The five ayurvedic panchakarma have been modified to suit the needs of modern life:

Herbal oil massage – A herbal warm oil is magged into the whole body to increase circulation and help the body eliminate toxic residue while purifying the blood.

Cleansing enemas – This is normally done after the medicated oil massage which helps improve circulation.

Nasal administration – This involves herbal nasal drops being administered through each nostril followed by deep breathing. This strengthens general immunity and helps keep the nasal passage and airways clear.

Gentle laxatives (senna) – These herbal formulations help correct vata imbalance, reignite the digestive fire and help the colon work properly. It helps promote normal bowel movement and treat constipation.

Specialized diet – As panchakarma is a detoxifying therapy to heal the body through cleansing , a specialised diet is given to follow that helps with the process.

Steam baths – The herbs added to the steam are based on your body and mind and specifically treat your imbalance. The steam bath helps the herbal oil from the massage go deeper into the layers of the skin for deep rooted benefits.

To enjoy the total benefits for both body and mind, of having panchakarma treatment done it is best to maintain the good lifestyle changes , which should become part of the daily routine.

* Practice mindfulness
* Eat at the right time
* Consume an appropriate quantity of food
* Understand the foods that benefit and the ones that are harmful
* Drinking plenty of water and other suitable beverages

The human body accumulates toxins and waste which make feel less than healthy over time. Panchakarma is a way of cleansing or resetting the body to help strengthen the immunity and for a sense of wellbeing. It is normally recommended that a healthy person undergo Panchakarma treatment at least once a year and anything more than that based on advice. Each panchakarma procedure is specifically designed after a thorough physical examination and can last from 7 days to even as long as 21 days, depending on the needs

Benefits of Panchakarma Treatments

The excellent body, mental, and emotional benefits of Panchakarma include:

* Detoxifies the body, cleaning out deep-seated toxins
* Improves digestion and metabolism
* Boosts immunity and vitality
* Benefits the skin, with possible slower aging
* Relieves stress and promotes mental clarity
* Restores the doshic balance for overall well-being.

Among the various positive effects on the body, Panchakarma therapy helps to rekindle the digestive enzymes, or Jataraagni. Optimal digestion and absorption helps to improve the production of Ojas that imparts vitality to the body. The Doshas that are imbalanced would be restored in a natural way. This is stated to be the best way to ensure good health. Ayurveda believes that Panchakarma purifies both the body and the mind. The disease-causing factors are removed, thus ensuring a state of wellness.

The [**Panchakarma Chikitsa**](https://www.ayurvedagram.com/kerala-therapies) or Ayurvedic treatment process aimed at cleansing the body of toxins is a part of the Ayurvedic treatment philosophy that originated nearly 5,000 years ago. The sages who developed the Ayurvedic principles and wrote treatises referred to this treatment procedure in their texts.

Before Panchakarma treatment is carried out, certain preparatory steps are needed. This helps ensure the body is prepared for the process of detoxification. This is necessary as a sudden expulsion of toxins may affect the body. The Purvakarma or preparatory processes include:

* Snehana or internal oleation by oral consumption of the prescribed medicated ghee in increasing dosage over 5-7 days. This is done with an aim to extract the toxins from the cellular level to the stomach for the ensuing purging procedure.
* Swedana involves generating controlled heat on the body by massaging it with prescribed oils or powders and herbal steam. The sweating process liquefies the toxins making them easy to be eliminated.

Once the preparatory processes are complete, the body is now ready for the controlled elimination of toxins. The ideal Panchakarma procedures are carefully customised according to the condition of the individual.

1. Vamana: This procedure involves induced vomiting to help balance the Kapha and is indicated in respiratory illnesses and skin ailments.
2. Virechana: Pitta when in excess causes digestive problems. The prescribed purgative helps purge the toxins collected in the stomach so that the balance of Pitta is restored.
3. Vasti: This procedure involves administering of prescribed oils and decoction combinations through the ano-rectal route to help balance the Vata.
4. Nasya: This procedure done through the nasal orifice helps decongest the sinuses and heal abnormalities of the cranial nerves.
5. Raktamokshana: This traditional method makes use of leeches or sterilized sharp instruments to remove impure blood from the body.

[**Panchakarma treatment**](https://www.ayurvedagram.com/treatment-programs/panchakarma-treatment)  is one of the prominent Ayurvedic tools used to restore balance to the body that helps to remove toxins and impurities from the body and mind through the use of herbalized oils, body treatments (including oil massage), steam therapy, herbal paste therapy, nasal therapy, vomiting therapies, enema therapy, and purgation therapies. Panchakarma is designed to allow the body to rid itself of wastes that have accumulated and lodged in the body, creating blockages in the intelligent flow of the various systems, including the circulatory, nervous, and digestive systems. The process helps to maintain the equilibrium of Doshas and thus restore a state of good health and optimize the functions of the gastro-intestinal tract, the nervous system, the cardio-vascular, the respiratory, the reproductive, the endocrine, the lymphatic systems in revamping the immune system and enables the body to resist infections and ensuring the relaxation of the body and mind to relieve stress and rejuvenates the body and can help slow down the aging process. Once the Panchakarma procedure is complete, the rejuvenation phase commences and the body can resume its natural functioning without interference. The use of a balanced diet, exercises through Yogasanas, Abhyanga (oil massages), and meditation help to rejuvenate the mind and body. This helps to prepare the body for a normal life once the procedure is complete. (267)

**Siddha medicine.**

Three traditional medicinal systems predominate in modern India: Ayurveda, Siddha, and Unani. Ayurveda is found mostly in northern India and in Kerala in the south, Siddha medicine occurs in Tamil Nadu and parts of Kerala, and Unani, which derives from Arabic medicine, is found throughout India, mainly in the urban areas. Tradition attributes a divine origin to Siddha medicine. Its knowledge is sacred and eternal, passed down to humans for the benefit of all humanity. According to Hindu tradition, the god Shiva transmitted the knowledge of medicine to his wife Parvati, who in turn passed it on to Nandi, from whom it was given to the first practitioners of Siddha medicine, the Siddhars. Tradition lists a total number of eighteen Siddhars, beginning with Nandi and the semi-legendary Agattiyar through to the final Siddhar, Kudhambai. They are the acknowledged transmitters of Siddha medical doctrines and practices.

By attributing a divine or extra-human origin to its medicine, the Tamil Siddhars have assured Siddha medicine a legitimate place in the corpus of Hindu knowledge. Although the transmission begins with Nandi, who in the form of a bull is Shiva’s mode of transportation, tradition attributes the origin of medicine as well as of the Tamil language to Agattiyar. According to Siddha cosmology, all matter is composed of two primal forces of matter (shiva) and energy (shakti). These two principles of existence operate in humans as well as nature, and connect the microcosm with the macrocosm.

This is expressed by the association between the human body and the signs of the zodiac in Indian astrology. Both the universe and the human body derive from the same five basic elements: wind, space/ether, fire, water, and earth. They combine to provide each individual with his or her unique configuration of the three basic humours or doshas in human beings: wind, bile, and phlegm, called the person’s basic nature. A skilled physician uses various methods, including the examination of the patient’s pulse and urine, to diagnose an imbalance in the patient’s basic nature. Treatment, aimed at the restoration of the imbalance, involves the use of plant-based and especially metal- and mineral based medicines, which are said to be imbued with an esoteric substance called muppu.

In addition to this cosmic connection which occurred in all traditions of Indian astrology, Siddha medicine relied entirely on Ayurveda for the medical doctrines that bridge the natural world and the human body. There are the five gross elements (pañcamahabhutam), which make up the entire natural world: solid/earth, fluid/water, radiance/fire, gas/wind, and ether/space. These combine in certain ways to give the three bodily humours, called muppini in modern Tamil. They are said to be in the proportion of 1 wind to ½ bile to ¼ phlegm, which is opposite to that found in Ayurveda:

1. Wind (Tamil: vatham, Sanskrit: vata) is a combination of space and wind, and is responsible for nervous actions, movement, activity, sensations, etc. It is found in the form of the five bodily winds. The five winds (Tamil: vatham, Sanskrit: prana) which circulate in the body and initiate and carry out bodily functions: pranam is the inhaled breath and brings about swallowing; apanam is the exhaled breath and is responsible for expulsion, ejection and excretion; samanam helps digestion; vyanam aids circulation of blood and nutrients; and udanam functions in the upper respiratory passages. There are also five secondary winds: nagam, the air of higher intellectual functions; kurmam, the air of yawning; kirukaram, the air of salivation; devadhattham, the air of laziness; and dhananjayam, the air that acts on death.

2. Bile (Tamil: pittam, Sanskrit: pitta) is made up of fire alone and takes care of metabolism, digestion, assimilation, warmth, etc. Its principal seat is in the alimentary canal from the cardiac region to small intestines. Ayurvedic formulations state that bile is a combination of the elements fire and water.

3. Phlegm (Tamil: siletuman, Sanskrit: shleshman, kapha) is a combination of earth and water and is responsible for stability in the body. Its principal seats are in the chest, throat, head, and joints.

According to Siddha, wind predominates in the first third of life, bile in the second third, and phlegm in the last third of life There is the shared doctrine of the seven tissues (Tamil: dhatu) of the body: lymph/chyle, blood, muscle, fat, bone, marrow, and sperm and ovum. The diagnosis of disease in Siddha medicine relies on the examination of eight anatomical features (envagi thaervu), which are evaluated in terms of the three humours

1. the tongue: black indicates wind, yellow or red bile, and white phlegm; an ulcerated tongue points to anaemia;

2. the complexion: dark indicates wind, yellow or red bile, and pale phlegm;

3. the voice: normal indicates wind, high pitched bile, and low pitched phlegm;

4. the eyes: muddy coloured indicates wind, yellowish or red bile, and pale phlegm;

5. the touch: dryness indicates wind, warmness bile, and cold, clammy phlegm;

6. the stool: black indicates wind, yellow bile, and pale phlegm;

7. the pulse

8. the urine .

Siddha pulse diagnosis (Tamil: natiparitchai, Sanskrit: nadipariksha), requires a highly developed sense of touch and a refined subjective awareness. According to Siddha, the following four conditions must not be present in the patient when doing a reading of the pulse:

1.oily hands, 2. a full stomach or hunger, 3. physical exhaustion, and 4. emotional distress.

The examination of the urine (muthira paritchai) is another form of diagnosis in which Siddha medicine has demonstrated particular expertise In addition to examining the urine for its colour, smell, and texture, Siddha medicine has developed a technique for determining the vitiated humour by reading the distribution of a drop of gingili (sesame) oil added to the urine. The meaning of the drop’s configuration is as follows: longitudinal dispersal indicates windy humour; dispersal in a ring, bilious humour; and lack of dispersal points to phlegmatic humour. Combination of two types of dispersal means that two humours are involved; the slow dispersal in a circular form and a drop that forms the shape of an umbrella, a wheel, or a jasmine or lotus blossom indicates a favourable prognosis. If, however, the drop sinks, spreads rapidly with froth, splits into smaller drops and spreads rapidly, mixes with the urine, or spreads so that its pattern is that of an arrow, a sword, a spear, a pestle, a bull, or an elephant, the prognosis is unfavourable. According to traditional Siddha thinking, a physician must be knowledgeable in alchemy, astrology, and philosophy to apply intuition and imagination; he/she should not seek fame or fortune from healing and should not treat a patient before a proper diagnosis has been reached; and should use only themedicines that he/she has prepared himself/herself..

The principle aim of Siddha medicine is to make the body perfect and not vulnerable to decay, so that the maximum term of life can be achieved. Siddha places emphasis on positive health, so that the object of the medicine is disease-prevention. Whereas Ayurveda prescribes a therapeutic regimen involving the “five purifying actions:” emetics, purgative, enemas, bloodletting and errhines, Siddha employs only purgation. Siddha medicine has excelled in ophthalmology. It has two separate treatises devoted to the treatment of ninety-six different eye-diseases. Toxicology has formed a separate part of Siddha medicine and seems to be closely linked to indigenous systems of treating snake bites and other forms of poisoning.

Closely connected with the tradition of the martial arts in South India there developed a type of acupressure treatment based on the vital points in the human body, known as varmam (Sanskrit: marman). In Siddha medicine the number of important varmam points is 108 out of a total of 400. Siddha doctors developed techniques of applying pressure to special points, called Varmakkalai, to remove certain ailments and of massaging the points to cure diseases. They also specialised in bone-setting and often practised an Indian form of the martial arts, called cilampam or silambattam. The Siddha system of rejuvenation therapy, known as Kayakalpa (from Sanskrit, meaning “making the body competent for long life”), marks the most distinctive feature of Siddha medicine. It involves a five step process for rejuvenating the body and prolonging life.

1. Preservation of vital energy via breath-control (Tamil: vasiyogam or Sanskrit. pranayama) and Yoga.

2. Conservation of male semen and female secretions.

3. Use of muppu.

4. Use of calcinated powders (Tamil: chunnam, Sanskrit: bhasma) prepared from metals and minerals, and

5. Use of drugs prepared from plants special to each Siddha doctor.

The esoteric substance called muppu is particular to Siddha medicine and may be considered as Siddha’s equivalent of the “philosopher’s stone.” Its preparation is hidden in secrecy, known only by the guru and taught only when the student is deemed qualified to accept it. It is generally thought to consist of three salts (mu-uppu) called puniru, kallupu, and vediyuppu, which correspond respectively to the sun, moon, and fire. Puniru is said to be a certain kind of limestone composed of globules that are found underneath a type of clay called Fuller’s Earth. It is collected only on the full-moon night in April, when it is said to bubble out from the limestone, and is then purified with the use of a special herb. Kallupu is hard salt or stone salt, i.e., rock salt, which is dug up from mines under the earth; or is obtained from saline deposits under the sea, or it can be gathered from the froth of sea water, which carries the undersea saline. It is considered to be useful in the consolidation of mercury and other metals. Vediyuppu is potassium nitrate, which is cleaned seven times and purified with alum.

This religio-medical form of therapy is the cornerstone of the Siddha medical practice and provides the basis for the rich variety of alchemical preparations that make up the pharmacopoeia of Siddha medicine. The alchemical part of Siddha is present from at least the time of Tirumular’s Tirumandiram (6th or 7th cent. C.E.), in which various alchemical preparations are mentioned. Since alchemy had reached a far greater level of development in Siddha medicine , it is believed that medical alchemy have begun in South India among the Siddha yogins and ascetics .

There are three groups of drugs in Siddha medicine: plant products (mulavargam), inorganic substances (thatuvargam), and animal products (jivavargam), which are characterised by means of taste (rasa), quality (guna), potency (virya), post-digestive taste (vipaka), and specific action (prabhava )

Siddha has classified the inorganic substances into six types:

1. uppu: twenty-five or thirty-one varieties of salts and alkalis, which are water soluble and give out vapour when heated;
2. pashanam: sixty-four varieties (thirty-two natural, thirty-two artificial) of non-water soluble substances that emit vapour when heated;
3. uparasam: seven types of non-water soluble substances that emit vapour when heated. They include mica, magnetic iron, antimony, zinc sulphate, iron pyrites, ferrous sulphate and asafoetida (hingu); (Sanskrit and Tamil: sahasravedi);
4. loham: six varieties of metals and metallic alloys that are insoluble, but melt when heated and solidify when cooled. They include gold, silver, copper, iron, tin, and lead;
5. rasam: drugs that are soft and sublime when heated, transforming into small crystals or amorphous powders such as mercury, amalgams and compounds of mercury, and arsenic;
6. gandhakam: sulphur which is insoluble in water and burns off when heated.

Rasam and gandhakam combine to make kattu, which is a “bound” substance, i.e. a substance whose ingredients are united by a process of heating. In addition there are thirteen varieties of gems and minerals, sixteen varieties of mud and siliceous earth, thirty-five varieties of animals, and twenty-four varieties of rocks. Mercury and sulphur, combined to make mercuric sulphide, are the cornerstones of Siddha pharmacology and have been equated to the deity Shiva and his consort Parvati. The crucial ingredient in almost every Siddha alchemical preparation is mercury or quicksilver, which is used in five forms (panchasthuta): pure mercury (rasa), red sulphide of mercury (lingam), mercuric perchloride (viram), mercurous chloride (puram), and red oxide of mercury (rasacheduram).

When combining drugs, Siddha has considered substances that form a natural affinity to each other, such as borax and ammonia sulphate, to be greater than the sum of its individual parts, and called it nadabindu, where nada is acidic and bindu is alkaline, or in the Siddha cosmology female Shakti mated with male Shiva. The most important mixture of this kind is alkaline mercury and acidic sulphur. It has devised a classification of drugs as friends and foes. The former increases the curative effect, while the latter reduces it. Six pharmaceutical preparations can be administered internally or on the skin and include: calcinated metals and minerals (chunnam), powders (churanam), decoctions (kudinir), pastes (karkam), medicated clarified butter (nei), and medicated oils (ennai). Particular to Siddha medicine, however, are three special formulations: chunnam, metallic preparations that become alkaline, yielding calcium hydroxide, which must always be taken with another more palatable substance (anupana, “after drink”); mezhugu, waxy preparations that combine both metals and minerals; and kattu, inextricably bound preparations, which are impervious to water and flame.

Sulphur and mercury or mercuric salts are combined to make them resistant to heat. While on the fire, certain juices are added by drops to empower the substance. The drug can be kept for long periods and given in small doses once a day. It should not, completely turned into a powder, but should be rubbed on a Sandal stone so as to yield only a few grains of the powerful substance. Siddha’s alchemy have devised slightly different methods for purifying or detoxifying metals and minerals, called suddhi murai in Tamil and shodhana in Sanskrit, before they are reduced to ash (Tamil: chunnam, Sanskrit: bhasman). Purification is done by one of two methods. One involves the repeated heating of sheets of metal and plunging them into various vegetable juices and decoctions. The other method, called “killing” (marana), entails the destroying of the metal or mineral by the use of power herbs, so that is loses its identity and becomes converted into fine powders, having the nature of oxides or sulphides, which can be processed by the intestinal juices.

After this purification procedure, the metal or mineral is combined with its appropriate acid or alkaline and is prepared for its final transformation into an ash or “bhasman” by incineration in special furnaces made of cow-dung cakes, which are replaced by electric ovens in more modern establishments. After the purification of the metals and minerals, they are then turned into ash or calcinated powders and are ready to be used as medicines Siddha medicine has devised a method with a special substance made of inorganic salts, in Tamil called jayani, which reduces the number of burnings to only three or four. In order to increase the potency of the ash (chunnam), Siddha practitioners add the esoteric substance muppu.

According to modern Siddha medicine different metals have different healing effects. Mercury is antibacterial and antisyphilitic; sulphur is used against scabies and skin diseases, rheumatoid arthritis, spasmodic asthma, jaundice, blood poisoning, and internally as a stool softener; gold is effective against rheumatoid arthritis, and as a nervine tonic, an antidote, and a sexual stimulant; arsenic cures all fevers, asthma, and anaemia; copper is used to treat leprosy, skin diseases, and to improve the blood; and iron is effective against anaemia, jaundice, and as a general tonic for toning the body. In terms of herbal drugs, the Siddha practitioners have a materia medica of at least 108 plants and plant products, some of which are imported from as far as the Himalayas. These vegetal drugs are used in three ways in Siddha medicine. certain drugs purify the minerals before they are transformed into ash. Many plant and plant substances are used to eliminate waste products from the body through a process of body purgation involving purgation of the nose and throat, enemas, and laxatives, and the removal of toxins from the skin by the application of medicated pastes.

Plants are employed in specific ailments and in the general toning of the body. Siddha doctors also used animal products, such as human and canine skulls in the preparation of a special “ash” or chunnam (Tamil: peranda chunnam), which is said to be effective against mental disorders The original form of Siddha medicine consisted principally in a series of treatments for specific ailments. The core of Siddha medicine is its alchemy .Siddha is one of the ancient medical systems in India considered as the mother medicine of ancient Tamils/Dravidians in south India. Siddha system of medicine is as old as mankind and dominated the civilazation of the southern penisula of India . (268-270)

**Varmam**  **therapy**

Varmam is a status in which the vital energy or the prana or the vasi spread throughout the body in all its systems including the flesh, bone, skin etc,. also without any huddles. “Varmam” is otherwise called as “Marmam”, because its activities are like a mistry. “Marmam” is having a single meaning as ‘Secret’. But, the word “Varmam” is an artistic term with multiple meanings.

**Other Names of Varmam**

Varmam is also called by other names. They are:

1. **Vanmam :**

Vamam means hitting strongly. Since it is a method attacking with a specific stepping method (chuvadu murai) this name might have been given.

2. **Kalam :**

Few varmam occurs only in a particular time. So such Varmam is known as kalam.

3. **Adakkam :**

When a Varma injury occurs at specific places, the Prana or Vasi which is the flow of the vital energy will be concentrated to certain points. Such places are called as Adakkam.

4. **Sootcham:**

Since Varmam denotes specific acute points this name sootcham was given. (sootcham –minute, concentrated,formula )

5. **Marmam:**

The word Marmam was given since those points are hidden and concealed. Vasi the unseen vital energy is rich in these areas, and so the name might have been given.

6. **Emum**:

“Emum” means protection. To protect from the enemies these places are used, so this name must be given.

**7. Eedu :**

With immature minds this is made equivalent to ordinary fighting techniques., so it is called as Eedu. This is a technique made equivalent to any technique to cure diseases and this name was given.

**8. Amirtha Nilai:**

Amirtha patcham and poorva patcham the revolution of the moon is related to the Amirtha Nilai, which is the vital circulation. So this name might be given.

**9. Vasi thanam:**

‘All Varmam spots are Vasi spots’. Which all places that Vasi stands those places are the Varma spots.

**10. Charam :**

Varmam is also called as Charam. Charam also is called by various names:

1. Vayu 10. Athma
2. Uyir 11. Param
3. Vasi 12. Swasam
4. Jeevan 13. Moochu
5. Puravi 14. Parama siva ananda avi
6. Kalan 15. Parasitta asaivu
7. Pranan 16. Varmam
8. Prakasa kattu 17. Prahasa aruvi
9. Arivu

Varmam is a subtle energy that assists the body's proper functioning (i.e., regulates air, blood and heat flow in the body). Varmam points are the locations where the Varmam energy resides and functions. Varmam is a siddha science that aims to fulfill the cultural, spiritual and medical needs of humanity. Life energy circulates human body in three forms like vatham, pitham, kabam. The dwelling or resting places of life energy are called varmam points. When the varmam points are stimulated with appropriate pressure, it produces a clear therapeutic efficacy. Varmam treatment is an external therapy in Siddha System of Medicine. It is purely anatomical and introduced bySiddhars for the human’s wellbeing. Specific anatomical complex parts of the body are stimulated in Varmam treatment. These points are manipulated over superficial nerves, vessels, bonyprominence, soft tissues, or their junctions. These energy points when hit by any external forces will cause severe illness. Siddhars have used these energy points for curing the illness. These points are stimulated either by giving pressures in circular manner or in pointing way constantly. Pulling certain muscles and tendons, blows, punch over certain areas of the body are executed. The Varmam treatment is much effective in orthopedic disorders like lumbar disc problems, cervical disc problems, Shoulder Impingement Syndrome, etc. Also, Varmam therapy consumes only a minimal time and effort. Siddha Varmam treatment requires no special instruments.

The places where the vaasi energy resides and activates both body and life-energy are Varmam points. These points are located in the junctions of nerves, naadis, muscle and bones. They are bio- energetic sites which aid physiological functions of the body.Varmam points are the places which activate, regulate, supplies energy and functions accordingto the body needs. The Varmam text “VarmaVilvisai” enumerates 8000 Varmampoints and Kumbamuninarambarai describes 251points14. Most of the Varmam texts enlist 108Varmam points of which 12 are paduvarmams and 96 are thoduvarmams. VarmaChinthamani explains there are 828varmam points which are situated in three regions (kandam) of the body. i.e., Vatha region which constitutes navel to foot and contains 190varmams, pittha region includes the area betweennavel and base of the neck comprises 366varmams, silaethuma region includes the regionabove the head containing 182 varmams and 90varmams are included in thondham.

Paduvarmams are the varmam points which are directly connected to brain energy and serve as major energy storage points. According to“Pingala nigandu”, the word ‘padu’ means brain. Thoduvarmams are the varmam points which are connected to paduvarmams. The word‘thodu’ refers to touch. It means through the act of touch, one varmam point gets connected to another varmam point. Each paduvarmam is connected to eight thoduvarmams i.e., 8 x 12 = 96Thoduvarmam. They serve as minor energystorage points. The total numb The total number of Varmampoints which accounts to 108 comprises two terminologies Varmam and Kaalam. The Word Varmam refers to static energy and the term Kaalam refers to kinetic energy. Varmam therapy treats Breathing problems, Bones dislocation. Nervous disorder, Heart diseases, Eye problems, Digestive Problems, Joint pains, The Varmam points are energy storage points which traverse through particular energy channels or streams. Proper stimulation of Varmam points helps in treatment of diseases. One who knows to apply varmam in a proper method by analysing the Vatham, Pitham, Kabam imbalance can treat diseases.

Varmam are vital points in the body that act as energy transformers or batteries. They form centers for boosting the vital prana flow through the intricate nadi system of the body. Nature by its design has protected these vital centers by placing them deep inside the body or by covering them with tissues inaccessible to normal attempts of breach. Scientific evidence is growing on the presence of sub microscopic energy channels in the body, nadi’s, as described by the Siddhars, yet science is too young to comprehend the intricate nadi system that governs the non-physical system of energy flow, the foundation of vital pranic forces. The Siddhars long ago had discovered the presence of 72,000 nadis in the body and have described in detail the action and location of each of them. They have also described the location of 108 varmam or vital points that could heal or harm the human body when properly manipulated, through touch, pressure or striking, by an expert.

Varmam therapy is a holistic therapy on its own and tackles the body, mind and spirit. A varmam expert understands the underlying links between the body, prana and the mind. Varmams have been classified based on the type of pressure needed to injure

(a) Paduvarmam (varmam due to injury),

(b) Thodu varmam (by touch);

(c) Thattu varmam (by blows),

(d)Thaduvu varmam (by massage);

(e) Nakku varmam (by licking); and

(f)Nokku (by staring).

The widely used and recognized ones are the 12 Paduvarmam’s and 96 Thoduvarmam’s . the Nokku varmam is the most awe generating and is rarely seen practiced, as those masters who were able to do this are almost extinct.

The Siddha massage or thadavu murai has been known for the application of varma points to achieve cures from disease. Varma or pranic points in the body are centers that control, regulate and maintain pranic flow and thus vital force distribution all over the body. In other words these varma points are pranic batteries that act as intermittent boosters to enable effective conduction of vital forces throughout the body. Any impact to these varma points due to accident or in combat will disrupt the flow of vital force. Depending on the location and activities controlled, the severity of the outcome of an impact will be anywhere between lethal to chronic damaging effects arising after several years.Siddha massage was born by the marriage of martial arts to Siddha Medicine. In the Siddha system this area of medicine is an elaborate and perfected science called Varma Kalai or the art of Vital points, where massage forms just one area of treatment. The depth of this varma science in Siddha is evident from the elaborate and extensive texts of Anatomy, Physiology, Diagnostic and treatment methodologies written on palm leaf manuscripts. Electron micrograph and photographs of a dissected human body show very thin filament coursing the body n , which are referred to be the same as nadi’s as explained in ancient texts, because they contained prana, proven using many bio-field devices.

Varmam, is a vital component of the T**amil Siddha medical system**. It is based on the concept of subtle energy that governs the body, mind, and soul. The points where this energy resides and facilitates vital functions are called**Varmam points.**These **108 energy points**act as reservoirs of pranic energy, distributed throughout the body. When the flow of this energy is disrupted due to injury, stress, improper diet, or physical strain, it affects the body's metabolic and physiological functions, leading to pain and disease.Before the use of herbs, minerals, and other medicinal substances, ancient healers discovered the power of using their own **hands for healing**—a practice called **Kai Maruthuvam,** now widely known as Varmam Therapy.

The goal of Varmam Therapy is to stimulate affected energy points through specialized manual techniques to restore the natural energy flow. By unblocking these points, the body regains balance, helping to alleviate acute and chronic diseases, pain, and disorders. Varmam Therapy is effective on its own, without the need for medications.

**Benefits of Varmam Therapy :**

* Complete  detox of negative energy within the body, allowing blockages to be removed to promote self-recovery
* Activate the inner-ability to rejuvenate and revitalize. Balance blood and energy flow throughout the body
* Instantly reduce symptoms of wide range of ailments /pain to in the body’s potential for self-recovery
* Work in conjunction with other allopathic therapy to boost body response
* Suitable as a  non medicinal treatment for  Acute/Chronic Pains

Varmam, that is a unique, special branch of Siddha Medical System plays a major role in promoting the drugless world, though it has its own special type of Varmam Medicines. Though varmam texts mention the existence 8000 varmam points in the body but there is general notation that there are 108 varmam points which serve as the basis for the art of varmam. They are classified in to 12 paduvarmam (points which are connected with the nerves of thebrain directly or indirectly and these points aid in alleviating brain related disorders) .Medical varmalogy affirms 12 stimulation methods for each varmam point to alleviate 48 different diseases. The uniqueness of the art of varmam is in abating 48 different diseases by stimulating a single varmam point.

The following are the general rules to be followed while administering varmam treatment:

1. Finger nails should be cut in both the hands and varmam points in the body should not be

touched by the finger nails.

2. Don’t talk to others while rendering varmam treatment and make the patient to sit or lie

down during procedure.

3. It is sufficient to cure the diseases by rendering varmam treatment twice a week. But

depending on the need of the patient and the intensity of the ailment, it can also be

administered daily.

4. For indoor patients, the treatment can be administered once in six hours daily (4 times

daily).

5. After rendering varmam treatment to each patient, it is necessary to touch the wall or any

wooden objects before treating the next patient. This is to avoid the transfer of the body

heat from one patient to another.

6. There are not many dietary restrictions for this treatment but it is better to avoid the

consumption of curd and greens at night.

7. The pressure applied should be based on the age and the body condition of the patients.

8. Don’t administer this treatment to patients who come with complaints of snake bite,

scorpion bite and poisoning cases.

9. Make sure that patient is neither fasting nor full stomach.

10. Preferable times is morning hours after rising from the bed and attended morning toilette

There are 12 methods of varmam application as following

1. Gentle movement

2. Mild movements

3. Clenching the varmam point along with the muscle

4. Slippery pinches

5. Mild tapping

6. Gentle stroking with fingers

7. Pressing point with a single finger

8. Balancing the energy of the points in the bone and joints

9. Placing the energy on the varmam point

10. Transferring energy from one point to another

11. Strengthening one nerve as that of the other

12. Touching and lifting the varmam point

All these 12 method can be executed on varmam point. The siddhars had propounded that the

application of these 12 techniques on single point is capable of curing 48 different diseases

Measurement and pressure . A profound knowledge of the finger measurement and the amount of pressure to be applied is essential for rendering varmam treatment. If the varmam point is touched either with the interphalangial joint of the thumb or the side tip of the thumb, it is considered as ¼ maathirai.

If a point is stimulated with the soft pulp portion of the middle finger that is from the tip of middle finger to the distal interphalangial joint then it is 1 maathirai. Similarly it is ¾ measures when the varmam point is stimulated with ¾ portion of this region and when ½ of this portion is used then it is ½ maathirai. In the art of varmam the pressure that has to be applied for treatment is the same as the pressure that is applied in the snapping of a finger. One snap of a finger is divided in to four stages:

1. Placing – ¼ maathirai pressure

2. Pressing – ½ maathirai pressure

3. Twisting – ¾ maathirai pressure

4. Releasing – 1 maathirai pressure

Using above stated four different maathirai along with the 12 application methods will enable

48 types of applications on a single vaarmam point. When ¼ maathirai pressure is applied,

the energy traverses through the bone marrow to cure the ailment. Similarly, for ½ maathirai

pressure the energy traverses through the nerve, for ¾ maathirai pressure the energy traverses

through the bones and for I matrai pressure the energy flows through the bone marrow, nerve

and the bones to cure the disease. (271)

Varmam is a unique, special branch of Siddha Medical System play a major role

in promoting the drugless world, though it has its own special type of Varmam

Medicines. In the world 90% of the population are suffering from headache in

their lifetime. Reasons behind headaches are many over exposure to Sun, problems

pertaining to brain, like lesion in brain, impaired blood circulation, lacking in

energy at brain, cold, eye problem, indigestion tiredness, hormonal imbalance,

stress hypertension and low pressure are the facts behind the origin of head aches.

Varmam points play vital role in alleviating the different headaches through different

set of Varmam points manipulation techniques. 80% of headaches are successfully

solved through careful selecting of Varma points and their manipulation for the

patients approached the Acugem house. Efficacy of Varmam in treating all

headaches are proved more effective in most of the cases without giving any drugs

Dr. Gayathri

Unnikrishnan | Dr. Ashvinikumar. M

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Marma is a point of concentration of Prana or vital

energy. The word Marma is formed from three

syllables -Ma, R and Ma. Ra symbolises Agni or fire

and Ma symbolises Soma or moon. Marmas are the

seats of three dosas i.e., Soma (Jal Tatva) Maruta

(Vayu Tatva) and Tejas (Agni Tatva) (representing the

three Dosas in the body i.e., Kapha, Vata and Pitta

accordingly) and three Gunas (mental forces) i.e.,

Raja, Satwa and Tama, and the Bhutatma (supreme

power or force controlling the body and mind or life

principle). Therefore, any trauma to these Marmas

can cause death

1

. Marmas are meeting place of

Mamsa (muscle tissue) Sira (blood vessels), Snayu

(nervous tissue), Asthi (osseous tissue) and

Sandhi(joints). A total of 107 Marma points has been

explained by Acharya Susruta

2

. A similar explanation

to that of Marma points is available in the Siddha

system of medicine. Siddhars created Varmamkalai, a

divine art form. Varmam is a subtle energy that assists

the body's proper functioning (i.e., regulates air,

blood and heat flow in the body). Varmam points are**hidden secrets about the Marmam**, injuries caused by hurting marma points and its **treatment aspects** with **colour photos** for better understanding. **Marma Chikitsa or Varma Therapy** is a special branch of **Siddha medicine**. **Varmam** is otherwise known as **Marmam** or **Jeevan**. A human body requires **Dasavayus** (10 vayus) namely **Pranan, Abanan, Viyanan, Udanan, Samanan, Nagan, Koorman, Kirukaran, Dananjayan, Devadathan**, for its proper functioning. Each vayu has its own function to keep the body healthy and disease free. Among all these **Pranan or Pranavayu** is the most important one. **Pranavayu controls the function of all other vayus. It flows across the six atharas, the three dasanadis (Idakalai, Pngalai, sulumunai) from vertex to sole.** The entire path of the pranavayu consists of junctions or places where it stays temporarily. These junctions are called Varmam. **There are 108 Varmam or Varma points in our body. Out of these 12 are Paduvarmam or the Varmams which when injured can lead to death. The other 96 are Thoduvarmam which are used in therapeutic purposes. When the body gets injured on a particular part due to some trauma leading to shock or fracture, the pranan changes its path and gets scattered from its original place to any other area.** During this time the person may experience excruciating pain which may also refer to other area leading to syncope, and even coma. These sorts of injury if not treated in a specific time period may lead to deadly or fatal conditions.**The signs and symptoms which the patient shows due to such trauma may mimic different other diseases and misguide the physician from the correct diagnosis. Such conditions can only be understood and treated by a honest, truthful, believer of God and his Guru (his teacher), experienced Asan or a Marmani.** The Asan, with his different therapeutic techniques and prayers can treat any Varma injury completely. They are noble people who serve the mankind without seeing their personal interest or in need of money.

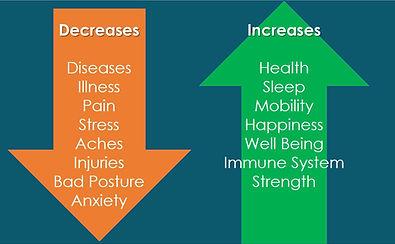


Fig.34. Marma therapy.

**Marma Therapy**

Marma is a point of concentration of prana or vital energy.

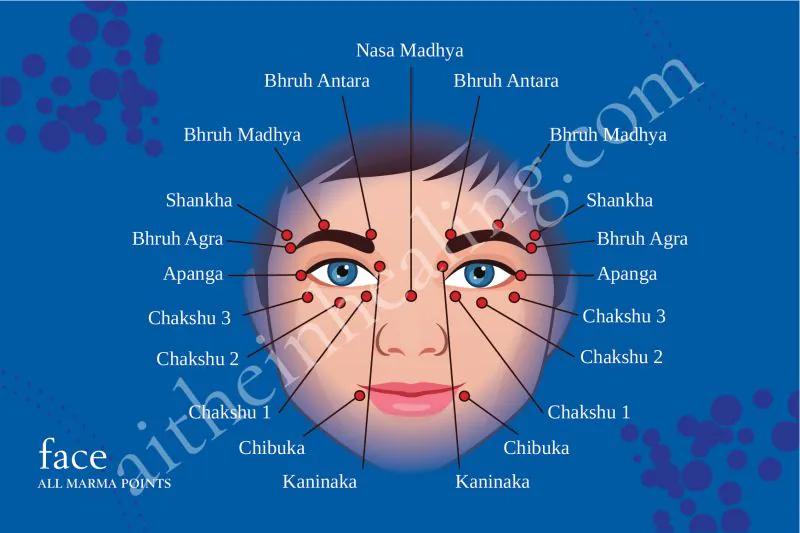
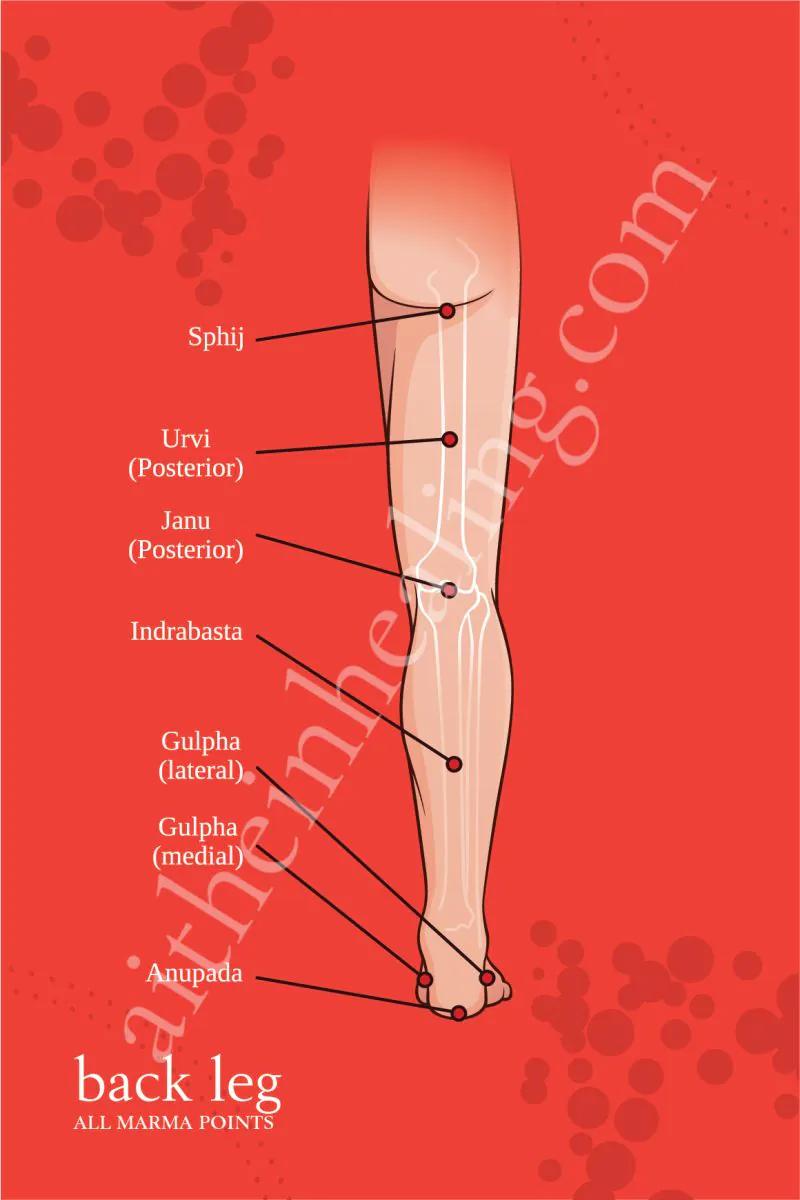
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Fig. 35. The [**marma points**](https://www.aitheinhealing.com/marma-points-introduction/) carry the vital “life force energy”. When these marma points are pressed, they work through the subtle energy channels called “nadis” to bring healing and energy to the body, mind and consciousness. Even though Marma means to cause harm or death. It can bring life force and give energy.**** fig. 36. Some marma points.

Marma therapy is an ancient healing practice involving stimulating vital energetic points in the body for increasing energetic flow for well-being. It is the root knowledge of acupuncture and acupressure systems and oldest known form of martial arts: kalaripayattu, or kalari.The 108 Marma Points Chart is a map of vital points across the body and shows exactly how each point is meant to revive or rejuvenate a specific organ, function, or process within itself. Being connected to the various processes within the body, how one breathes, how one uses muscles, etc. is also essential to understanding the way to access these points more accurately for a more holistic understanding of every aspect of how one’s being is connected, and influenced by one another. It also encourages the use of the nature of life. Life is vulnerable and within that vulnerability lies a certain strength and power as well. The chart allows one to realize which area of the body is connected to the others and how to encourage a ‘communication’ system between these areas.

According to the Marma Chart, there are 108 points — 107 on the physical body and one in the mind. Each point corresponds to a specific vayu (function of prana), dosha (constitutional type), dhatu (bodily tissue), and srota (physical channel). The health of the body is determined by how freely ‘prana’ flows from the ‘nadis’ through these points. Any disruption to this flow causes impairment to one’s health. These points range in size from one to six inches in diameter. The points were mapped out in detail centuries ago in the Sushruta Samhita, a classic Ayurvedic text. Major points correspond to the seven chakras, or energy centers of the body, while minor points radiate out along the torso and limbs. The points cover both the front and back body, including 22 on the lower extremities, 22 on the arms, 12 on the chest and stomach, 14 on the back, and 37 on the head and neck. The mind is considered the 108th marma. Traditionally, the points are grouped into 3 categories… Those on the legs and feet are Sanakha Marma; On the trunk, Madhayamanga Marma; and on the neck and head, Urdhavajatrugata Marma.

**The history of Marma**

Marma Therapy developed in conjunction with the traditions of Kalari, a form of martial arts which originated in Kerala, India. The ancient Kalari warriors were trained in Yoga to still the mind, strengthen the body and eliminate obstacles in their path to victory. They were also skilled in Ayurvedic medicine for tending to their wounds, including various forms of herbal applications and bodywork. The art of Kalara is still alive today in Kerala. Manipulation of the vital points can both heal and harm, and the knowledge of Marma was kept sacred and reserved only for the initiates who could be trusted with this knowledge. Marma Therapy and Kalari were transferred between ancient civilizations in the Far East and protected traditions for a long time, and they influenced the development of traditions in other regions, Traditional Chinese Medicine, Kung Fu, and acupuncture. The largest difference between Marma and acupuncture points is that the Marma points are measured in a finger unit relative to each individual, and they are larger in size and they are not related to meridians like they are in Traditional Chinese Medicine.

The word “Marma” refers to the specific energy points that are intersections of the body’s energy channels. Anatomically, it can involve the intersection of any of the following: muscles, arteries, veins, nerves, ligaments, bones, and joints. These points contain vast amounts of life force energy, or *Prana*, which is identical to the TCM concept of *chi*. Marma Therapy involves gentle stimulation of the points through light touch, massage, and pressure. Once stimulated, the flow of energy can be unblocked and aligned. Marma Therapy can remove blockages so the energy flow can continue on its natural path. When addressing an injury, increasing energetic flow can also provide additional support to the healing process. Balancing energetic flow leads to overall health and wellbeing.

As Marma points are the seats of life, they contain all forms of subtle energy: the Doshas (Vata, Pitta, Kapha), Subtle Doshas (Prana, Ojas, Tejas), and Mental Doshas (Sattva, Rajas, Tamas). Just as the energy flow of these centers can be manipulated to increase life force and wellbeing, it can also be manipulated to decrease life force. Some of the points are known for receiving therapeutic benefits in Marma Therapy, while others are known as lethal areas. Whether intentional or by accident, the lethal areas can cause injury or death when triggered. For this reason, it’s important that students of Marma Therapy are trained to understand the exact locations of the 107 Marmas and how to safely manipulate these points.

Marma points are stimulated by massage to achieve healing effects to specific areas of the mind-body system. Marmas are sensitive areas so massage should be done carefully. The duration of the Marma point stimulation should be at least 3-5 minutes.The traditional principles of Marma Therapy include wisdom from Sushruta, Charaka, and Vagbhata. Marma Therapists must learn and memorize the 107 locations of the points, as well as how to conduct a therapeutic stimulation of these points. In addition to the technicalities of this process, advanced practitioners are trained in assessing an individual’s constitution and imbalances for applying clinical Marma support. Because Marma Therapy is a touch-based practice.

Marma points are not only anatomical landmarks but they are also the sites where tridosha are present with their subtle forms Prana, Ojusa (soma) and Tejas (agni). They also contain 3 gunas namely sattva, raja, tamas (manas contents) and soul or life force (bhutatma). Manipulating or stimulating Marma in the management of various diseases is called Marma Chikitsa/ Therapy. Through stimulation of marma by various methods the Prana (vital energy) existing in marmas may be directed to remove blockages (even in remotely connected areas) and stimulate energy flow thus resulting in a state of healthy body, mind and spirit.

Marma is defined as anatomical site where muscles, veins, ligaments, bones and joints meet together. There are one hundred and seven (107) marmas (vital spots) out of which eleven arepresent in each limbs, twenty six in trunk (three in abdomen, nine in thorax, fourteen in the back) and thirty seven in head neck region. The term marma is used for diseases of vital organ system by stimulating topographical cure points the topographical cure points, Marma is the point on the body where the blockage of energy is felt It is the junction between physiology and consciousness, and by touching it changes the body’s biochemistry and can unfold radical and alchemical change in one’s make up Stimulation of these inner pharmacy pathways signals the body to produce exactly what it needs including hormones and neurochemicals that heal the body, mind and consciousness Marma points are specific areas on the body, which have relation through pranic channels to various internal organs, doshas and srotas. These points are being used with the application of different kinds of medicated and aromatic oils to stimulate internal organs . Marmas are invisible but could be traced at a point where body, mind and psychic energies are concentrated together. These points are located at nadis, nerves, blood vessels, junction of bones, muscles and tissues.

Manipulating or stimulating marma points in the management of diseases is called marma chikitsa and it is an inherent power of human to heal itself through these points. Through stimulation of marma by various means and methods, the Prana (vital energy) existing in it may be directed to remove blockages (even in remotely connected areas) and stimulate energy flow thus resulting in a state of healthy body, mind and spirit. A judicious application of pressure on appropriate marma can restore the normal functioning of prana (in diseased body parts) where as their improper manipulation may cause severe pain, disability, deformity and even death.Marma science is part of Vedic science that has influenced all other sciences like Ayurveda, Yoga, Martial arts, Sidha system of medicine etc. which are found in Veda (400BC). In Mahabharata, the great epic many references for Marma or Varma were found..

Martial art became effective and popular for self defense because the monks were able to protect themselves against weapons due to knowledge of marma. As non violence was taught by this religion, they were not allowed to use weapons even for their self protection, hence the art of marma was taught to all monks for unarmed self protection. This art was kept as secret for centuries, as it was taught only to certain disciples. As the monks started travelling to various countries like Japan, China, Indonesia etc. this art also spread to these countries. It is therefore very certain that the traditional Chinese medicine had adopted this science from Ayurveda. Its importance is explained by the Sanskrit phrase ‘Maryanti iti marmani’ which means that any harm to these points is hazardous or any injury to these parts may lead to severe pain, disability, loss of function, loss of sensation and death Marma also means secret or latent power .

Classification of Marma

There are total 107 marma (upper and lower limbs 44, back-14, chest and abdomen-12, udarvajatrugata-37) in the body. These are divided into different groups according to the physical matrices and also on the basis of their special features.

Indications of Marma Chikitsa

1. Musculoskeletal disorder

2. Alimentary tract diseases

3. Respiratory tract diseases

4. Cardiovascular diseases

5. Neurological diseases

6. Genitourinary tract diseases

7. Metabolic disorders

8. Eye and Ear related disorders

9. Cerebral palsy, down syndrome, mental retardation, autism, speech disorders etc.

Marma points are a double edged sword, whose results primarily depend upon the nature and extent of their stimulation.

Role of Marma Therapy

1. Removes blocks in energy channels (srotas).

2. Pacifies doshas bringing it to normal path (especially vyanvayu which controls autonomic

nervous system).

3 Creates physical, mental and emotional flexibility.

4 Creates an opportunity to experience powerful and dynamic transformation at physical,

mental, emotional and spiritual level by building a positive link with the unconscious mind.

Disadvantages of Marma Chikitsa

During ancient times, knowledge of marma was known to kings and warriors. It was applied in battle fields to hit and achieve maximum lethal effect on enemies. This science was used both in warfare, surgery and later on martial arts too. Therefore if not used judiciously it can cause minor pain and disability to death of a patient or person. Kshipra marma is related to head, brain, pituitary, pineal, hypothalamus, neck, throat, thyroid and parathyroid in acupressure where as in acupuncture stimulates lymphatic system Marma science is the combination of scientific attitude and religious practices by the mediation of experiential philosophy and is part of the human beings' long experience in day to day life for the achievement of mortal and immortal gains. Marma science is an instant, permanent, natural, non-invasive way of healing today, because it succeeds in conserving many of the highest moral values of its adherents. It promotes calmness; self control, self healing, realization and happiness and does much to prevent sufferings and sorrow. Those who believe in the self-healing power of the human body, live better lives than many who do not, because they depend more on this science than the other conventional medical practices.

The realization of the recognition of the healing power of marma therapy is an experience which is superideational. There is no word which can be employed to designate the scope and prospects of marma therapy.Among the hidden sciences (Gupta Vidya) of India, Marma science is the most important. The human body is the basis of all types of activities. One can achieve many mortal and immortal gains from this body.

These marmas can be categorized in to 5 groups according to the effect of trauma on it.

1. Sadya pranahara (fatal) marma -19

2. Kalantara pranahara (delayed fatal)- marma-33

3. Vishalyaghna (fatal after removal of foreign body) marma- 3

4. Vaikalyakara (disabling) marma-44

5. Rujakara (painful) marma- 8

Fatal marmas are agneya in nature. Injury to these points may lead to sudden decline in vitality and death. Delayed fatal marmas are saumyagneya: there is sudden decline in agneya property but there

is insidious decline in saumya property; so there is delay in fatality and death takes place after some time. In cases where fatality occurs after removal of the foreign body the marmas are vayavya in nature. After injury there is cessation of air and removal of foreign body may lead to sudden loss of internal air and death. But if the foreign body is not removed and the wound heals spontaneously and the foreign body falls off by itself then the effect is not fatal.

Disabling marmas are saumya in nature. Soma is stable and cold. It protects life. Any injury to these parts is not fatal but may lead to disability. Painful marmas are combination of agni and vayu properties. Any injury to these points may lead to severe pain. It has been said that all the five basic body elements are involved in the marmas. In the fatal points vein, ligament, muscle, bone and

joint,- all are combined. When all these fractions are present in less quantity or one fraction is absent then it is known as delayed fatal marma. If two fractions are absent it is known as the marma which

is fatal after removal of foreign body. If three fractions are absent then these points are known as disabling marmas. If only one fraction is available then these points are known as painful marmas.

The term marma is derived from the Sanskrit dhatu ‘mri’— marma, that means which causes death or disability. The literary meaning of marma is shape, element, life spot, conjugation of different body structures, essence and vital part. It is apparent that there are certain important vital points (places) in the human body, which have hidden, secret and significant energy.

All marmas can be categorized in six groups,

a) Mansa marma (Marmas of muscles)

b) Sira marma (Marmas of blood vessels)

c) Snayu marma (Marmas of ligaments/tendon)

d) Asthi marma (Marmas of bones)

e) Sandhi marma (Marmas of joints)

f) Dhamani marma (Marmas of arteries)

In every marma the structural contents may be different. When there is predominance of muscle tissue, it is known as ‘mansa marma’. Other structural tissues are also present in that particular spot. The same concept is behind the classification or categorization of all the marmas

Marma chikitsa can be used in the following ways—

a) To treat the diseases of nerves and brain.

b) In traumatic neurological or neuro surgical lesions, traumatic paraplegia, hemiplegia and monoplegia.

c) In orthopaedic lesions, especially prolapsed inter vertebral disc etc.

d) To reduce the pain of nerves, muscles, ligaments, bones and joints.

e) To produce anesthesia during any surgical interference.

f) To improve the function of body organs by achieving homeostasis.

g) To activate the mal-developed or deformed body parts or musculature etc.

The different methods of marma therapy include

1. Deep breathing and holding of air in the chest, upper respiratory tract and mouth. This stimulates the 37 marmas of the neck and head.

2. Posturing of body. Examples are to be drawn from normal human postures which are adopted by human beings in day to day life like inter-digital pose, cross-hand and cross- legged pose as well as Yogasanas in which stimulation of marma points is inherent.

3. Pressure over the marma points, vibrating, pinching and lifting the skin layers over the marma points and application of medicaments and oil massage over the marma points.

Marma therapy is an uncomplicated and easy-to-learn technique of regaining the vital energy.

Posture: - For successful practice of self-marma therapy, posture is important. The practitioner must remain steady, quiet and mentally alert during this practice. A sitting posture is most convenient for the practitioners. Usually one should assume a posture of cross-legged position, keeping the spine erect. Keep the hands on the knees in upward position or one can adopt the jnana mudra.

The most common postures for the practice of self-marma therapy are-

1. Simple cross-legged posture (Sukhasana)

2. Lotus posture (Padmasana)

3. Half lotus posture (Ardha padmasana)

4. Diamond posture (Vajrasana)

5. Sitting posture on chair

6. Standing posture

In exceptional circumstance, lying down position (recumbent posture) may also be adopted.

Marma therapy and yoga are important to cure the disease and enhance the health status of the body. Nowadays asanas are much popularized in the society for health promotion. It improves the health and tones up the body musculature. These practices affect the body physiology. Marma therapy and yogic postures, as well as marma stimulation inherent in them, have great impact on nervous system, musculo skeletal system, endocrine glands, respiratory system and organs of abdomen, heart and circulatory system. These marma practices and yogic exercises are developed by ancient rishis by observing Nature.

Marmas are the seats of Prana (vital life force), i.e. the subtle energy centers where the Prana resides and flows Prana is the vital life force that governs all the physical and subtle processes of a living being . Thus, the stimulation of these centers implies stimulating the flow of Prana, rather than some physical organs or tissues Since the Prana signifies live electricity flowing through the body, hence the Prana of the therapist is bound to interact with that of the subject thus, the exact location of the Marmas should depend upon the Prana of both the therapist and the subject, and may not be simply a fixed physical site Therefore, the identification of Marmas may not be a simple physiological definition, but instead a matter of long-term practice and concentration;

Classification of Marmas According to their Therapeutic Use scholars have given therapeutic classification of Marmas, which is as follows

1. Sthula (physical) and Sookshma (subtle)

I. a) Sthula The locations and anatomical structure of various marmani are included here. These marmani can be assessed by naked eyes, i.e. Pratyaksha darshana.

b) Sookshma Here, various subtle physiological functions are included, which are known and understood through Apta vachana (words of Sages / Rishis) and Anumana pramana (i.e. literature, clinical assumptions, and teachings of experts).

1. Vulnerable (lethal) and Less vulnerable (therapeutic)

a) Vulnerable (Lethal) This includes marmani that are fatal, if stimulated in the wrong manner; therefore, one should be extremely cautious while dealing with these. Wrong stimulation of these points can lead to severe injury, unconsciousness or even death These include Sadya pranahara marma, and neck marmani.

b) Less vulnerable (Therapeutic) These are the locations that can be treated for healing purposes These marmani are comparatively safe, as the effect of wrong stimulation is usually less disastrous; these can be good starting points for inexperienced clinicians. These mainly include shakhagata marmani (of limbs) and prishthagata marmani (of back).

1. External and Internal

a) External These are the marma points / sites located near the external surface or skin. These can be identified easily and manually stimulastimulated. These include shakhagata marmani, marmani of supraclavicular region (like sthapani, apanga, simanta, krikatika), some marmani of back (like ansa, ansaphalaka, vrihati), etc.

b) Internal These include the marma sites that are deeper inside the body, and are not easily located from outside; usually these are stimulated by using the corresponding skin zones or landmarks. These include all marmas of abdomen and chest, and some marmas of supra-clavicular region like adhipati, nila, manya, matrika, phana, shringataka, etc. Instead of using the direct pressure technique, these marmani are stimulated through indirect applications, which include procedures like nasya, basti, pichu; use of some medications like ghee, oil, etc.; or by using asanas, pranayama, bandhas, etc..

The methods of Marma Therapy have been broadly classified into two categories, i.e. With Medicine (Pharmacological) and Without Medicine (Non-Pharmacological) . According to the scriptures, 'Havya Vaha' and 'Kavya Vaha' Tadit Shakti (bio-electric power), resides in the Marma locations . The positive electricity named 'Havya Vaha' resides in the Marmas of the head and the torso, while the negative electricity named 'Kavya Vaha' resides in the Marmas of the hands and legs Imbalance of the Havya Vaha and Kavya Vaha Tadit Shakti residing in the Marma points results in the occurrence of disease and weakness .

In order to provide relief from this suffering by regaining this balance, the ancient sages invented Yogasanas (Yogic postures) The stretching, vibration, rhythmic movement and pressure caused by Yogasanas have a direct influence on the Marma points, and play an important role in their refinement, stability and nourishment subsequently, the functioning of the respective organs with which the specific Marmas are associated, also gets affected leading to therapeutic benefits For example, Kshipra, Gulpha, Indravasti and Janu Marmas are stimulated during Vajrasana and Supta Vajrasana, which are useful for knee pain/ strengthening of knee in a healthy person this indicates the effectiveness of the stimulation of these Marma points in knee disorders.

Marmas are connected to the Nadis (subtle nervous system) and Chakras (subtle energy centers) of the subtle body The Chakras can be considered to correspond to seven main Marmas or Pranic centers, which provide energy to all other Marmas Through stimulation of Marma points, the flow of Prana through the Chakras can be stimulated, thus activating them; the activation of the Chakras results in the awakening of subtle dormant areas in the brain, that leads to the experiencing of higher realms of consciousness, which are normally inaccessible this, in turn, can lead to better control over the mind-body network including the autonomic nervous system and various organs, resulting in an overall healing effect Marmas are related to the three Doshas (Vata, Pitta and Kapha). According to Ayurveda, a healthy human body is supposed to have a relatively stable equilibrium of the three Doshas (Vata Pitta and Kapha) Imbalance in this equilibrium leads to disease, and the aim of the therapy is to restore this balance (271-274)

**Energy-like somatic experiences (ELSEs)**

There are numerous historical and textual references to energy-like somatic experiences (ELSEs) from religious traditions, and even a few psychological studies that have documented related phenomena.

Historical Background of Energy Systems and Associated Practices

The main body of literature on energy systems is historical. This includes translationsof key texts from religious, contemplative, and/or medical traditions on theories of thephysical or subtle body, on the ﬂows of subtle body “energies”, or sometimes “winds”,and on the relationship between the body and the world at large. References to subtleenergies in various forms occur across a range of textual sources, from the Upanishads ofancient India, Asian religions—such as the Yogic and Tantric traditions of Hinduism and Buddhism, theinner alchemy practices found in Daoism,to classical Chinese medicine, to New Age spirituality. Many of these traditions have a long history of dialogue, exchange, orsyncretism, both across religious systems and between religious and medical traditions, Tibetan medicine provides diagnoses and suggests treatments for various disordersin which subtle body “energies”, or “winds” (Tib. rlung), can become imbalanced bynumerous causes, including meditation practices Tibetan Buddhist lineages also inherited from South Asian Tantrictraditions a conception of subtle body energies that is soteriological in nature.

Speciﬁc advanced contemplative practices, such as the techniques for the generation of innerheat (Tib. gtum mo), and the movements of the “magical wheel” (Tib. rtsa rlung ‘phrul‘khor), are understood to directly manipulate the subtle body energies through breathing,postures, physical movements, and/or visualization. Thesepractices have the proximate aim of purifying or removing various karmic obstructionsto the subtle body by circulating the “energies” or “winds” (Tib. rlung) through a seriesof “channels” (Tib. rtsa) and “centers” (Tib. ‘khor lo). Despite myriad differences among the various systems of subtle body anatomy, andin the practical methods for engaging with subtle energies, most contemporary sourceson this topic take as paradigmatic either the system of acupuncture and acupressurepoints through which energy (Chn. qi) ﬂows in Chinese medical traditions, or the system ofchannels (nadi) and centers ( cakra) that mediate the movements of breath, winds, or vital energy ( prana.)

According to South Asian Yogic and Tantric systems, the female serpent goddess, kundalinı,a manifestation of divine energy (Skt. ´sakti), lies coiled in the cakra associated with thebase of the human spine. When stirred through Yogic and Tantric practices, the energymoves through the subtle body, and in particular up through the cakras associated with thecentral channel. These notions of the subtle body and the practice of stirring kundalini dateback to Indic sources on Yoga and Tantra from around the 9th century CE . The prominence of South Asian conceptions of the subtle body and subtle energies inNew Age spirituality can be traced back to their popularization by the Theosophists in thelate 19th and early 20th centuries Against this backdropalso emerged C.G. Jung’s lectures on kundalini in the early 1930s and the prominence of theconcept of “kundalini awakening”.

The phenomenology of a kundalini awakening iscentered around ELSEs described as “powerful sensations of heat and energy streamingup the spine, associated with tremors, spasms, violent shaking, and complex twisting movements” , but also contains other behavioral,physiological, emotional, and perceptual changes. Research based on this conceptionhas produced several scales assessing a range of anomalous phenomena For instance, physio-kundalini syndromeincludes not just ELSEs, but also involuntary movements, thermal changes (heat and cold),somatic, visual, and auditory hallucinations, autoscopic dissociative experiences, intensepositive and negative emotions, paralysis, and racing or slowing thoughts. While the nonpathological model acknowledges the reality of spiritual emergencies other approaches attempt to establish a differential diagnosis with mental illness and present kundalini awakening as aculturally speciﬁc interpretive framework that patients might invoke to account for unusualexperiences

Multiple ELSEs are part of a standardized taxonomy of experiences in schizophrenia spectrum disorders under the heading of “cenesthesias” “Migrating sensations” may be “ﬂuctuating, wandering, circling or rising” throughoutthe body. Similarly, “sensations of movement, pulling and pressure” may be describedas “vibrating”, “quivering”, or “simmering” among others. “Electrifying sensations” may appear as a “strange feeling, starting in the feet and radiating up to the head, like electricity”, and can be “horrible” or “quite pleasant”. “Thermic sensations” of heat, burning,

or coldness may be “diffusely wave-like”, “ascending”, or “circumscribed”

Cenesthesias may also be accompanied by emotions and/or emotionalrelease. Cenesthesias typically ﬂuctuate in intensity and may last seconds, minutes, hours,days, or even months or years. In a sample of ﬁrst-episode psychosis patients, cenesthesiaswere one of the most common symptoms, reported by the majority of patients (67%).Anomalous bodily experiences are signiﬁcantly correlated with lower levels of physicalactivity. (275)

### Dhara therapy (Relaxation Therapy)

### In Dhara therapy, prolonged and intermittent stimulation by the dripping oil may provide afferent inputs to the cerebral cortex, leading to a tranquilizing effect. Dhara, in it's literal translation, implies "flow". In Ayurvedic treatments, Dhara is a form of treatment in which a continuous stream of warm oil, buttermilk, milk or a extracts of herbs are to flow in a rhythmic manner, to treat specific body parts or ailments. With this method, the oil or the medical concoction runs through the pores into the body, thus triggering the healing mechanism of the body and mind to restore good health. This treatment is soothing, relaxing and acts as a very effective method of cleansing the body of various toxins There are different types of Dharas, each of which cures a different health issue. The herbal oil mixture used in each is also different. The method of treatment is chosen based on the nature of the illness. Dhara is generally administered over a period of seven to fourteen days, in sessions that last 30 to 90 minutes each.

The three major forms of Dhara are Shirodhara (Dhara on the forehead), Sarvangadhara (Dhara on the entire body) and Pizhichil (Dhara by squeezing an oil-soaked cloth). These are further sub-divided based on the composition of oil used. Dhara is a highly effective form of sudation therapy that aids in the treatment of a wide range of ailments including headache, depression, muscle spasm and joint pain.This treatment is a relaxing process to relieve stress and loosen muscle stiffness. There are many types of Dhara Treatments for different diseases and affected areas. ‘Dhara’ which means stream, in Sanskrit denotes the stream-like usage of medicated oils, medicated milk, ghee, coconut water and other natural ingredients, during the process.

Categorically Dhara Ayurvedic treatments are of following types

**Shirodhara** called as the ‘third eye’ treatment, Shirodhara involves creating warm herbal oil streams on the forehead, scalp and hair. This treatment rejuvenates the body and mind by tranquilizing the entire nervous system. Very beneficial for Insomnia, sinusitis, depression, migraine, cervical disorders, Shirodhara proves to be an ideal tranquilizer. It is classical and a well-established ayurvedic procedure of slowly and steadily dripping medicated oil or other liquids on the center of the forehead of the patient, resting quietly on a comfortable bed. Other liquids like coconut water, buttermilk, milk, etc. are also used depending on the individual need of the patient. The etymology of *Shirodhara* is from *shira* = head and *dhara* = a steady flow.

This procedure induces a relaxed state of awareness, which results in a dynamic psycho-somatic balance. A total feeling of wellness, mental clarity, and comprehension is experienced in this process. In classical Shirodhara, a copper vessel (kumbha) with a standard size hole at the bottom is used. This is filled up with oil or any other therapeutic liquid at ambient temperature. The rate of dripping is approximate, dependent on the volume of oil and the size of the aperture. As a consequence, there is a substantial variability in the procedure. The modified procedure is as follows:The subjects, resting in bed, are given a soft, full body massage for 15 min with 50 mL of sesame oil by an Ayurvedic expert. Later, the oil is gently wiped off the body.

A continuous dripping of Shirodhara oil is initiated and maintained for 45 min; the locus of the drip is the recommended spot, between the eyebrows, on the forehead. The rate of the drip is assured with a peristaltic pump at the outlet of the oil reservoir. The temperature of Shirodhara oil is kept at 40 ± 1.5°C with a thermostatic control. The eyes are covered with soft and sterile gauze pieces. The subjects stay supine throughout the study. The patients are not restrained from sleeping. They may feel a relaxed state of alert awareness and occasionally mild drowsiness.

Shirodhara is deeply relaxing and induces a relaxant state; these effects are mediated by the brain wave coherence, alfa waves, and a down regulation of the sympathetic outflow. The center of the forehead, which was evolution wise related to the third eye, is connected atavistically to the pineal gland. This spot is known as Agnya Chakra in the yoga tradition. Focusing on agnya chakra with closed eyes during meditation leads to psychosomatic harmony. As the oil drips on the agnya chakra, it is proposed that the meditation-like effect is a consequence of stillness of mind leading to adaptive response to the basal stress.

Shirodhara comes from the two Sanskrit words “shiro” (head) and “dhara” (flow). It’s an Ayurvedic healing technique that involves having someone pour liquid — usually oil, milk, buttermilk, or water — onto the forehead. It’s often combined with a body, scalp, or head massage.Shirodhara is said to have relaxing, soothing, and calming effects on the body and mind. Shirodhara may help:

* [improve sleep quality](https://journals.sagepub.com/doi/10.7453/gahmj.2012.086)
* [manage insomnia](https://journals.sagepub.com/doi/10.7453/gahmj.2012.086)
* [lessen anxietyTrusted Source](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6937873/) (when combined with yoga)
* [reduce stress](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3667433/)

Shirodhara involves the application of medicated oil on the patient's forehead. During the treatment, the patient is made to lie face up on a Droni (Ayurvedic therapy table), with a Vartti (headband) tied around the forehead. A vessel with a central orifice is filled with medicated oil and suspended six to eight inches above the patient's head. The flow of oil is set at a controlled rate. The headband protects the eyes in case of any oil spillage.



Fig.37. Shirodara treatment

**Thakra Dhara:**The Sanskrit word Thakra means buttermilk. Thus, in this therapy, medicated buttermilk is poured over the forehead along with the oil. This treatment has many therapeutic effects, especially in the improvement of the patient's mental health. It offers relief from Vata-related diseases and stress disorders.Results show acute reduction in psoriasis, digestive problems, psoriasis, headaches and graying of hair.



Fig.38. Shirodara treatment

**Ksheer Dhara:**Best availed in the summer season, this form of Ayurvedic treatment involves milk pouring along with herbal oils over the head and body. Used  to cure Vatha and Pittha disorders, Ksheer dhara brings relief in mental tensions, insomnia, headaches and body aches. The treatment should be continued uninterrupted for a specific amount of time. During the post-therapy bath, green gram paste and herbal shampoo are used to wash away the oil.

* **Dhanyamla Dhara:**It is an Ayurvedic massage therapy in which luke warm medicinal liquid is poured on different parts of the body. Practiced for curing various types of spinal disorders, neurological disorders, arthritis, asthma, spondylosis and more, this treatment is a sure shot formula for physical and mental well being.

**Sarvanga Dhara:**Based on the internal body type of the patient, in this Ayurvedic treatment  6 to 7 liters of warm medicated herbal oil is poured and systematically massaged on all parts of the entire body as the patient lies on a Droni (Ayurvedic therapy table). Very effective in curing all types of degenerative disease, this therapy relieves you from muscular pains, joint stiffness, hormonal imbalances and skin diseases Ideally, five attendants are required for performing the therapy. Using kindis, or brass spouted pitchers, four practitioners simultaneously pour the oil, and massage the patient from head to toe. One attendant regularly replenishes the oil.



Fig.39. Shirodara treatment

* **Nethra Dhara:**Done for rejuvenating eyes, the treatment involves washing eyes with Triphala water for cleaning the eyes plus removing different kinds of eye problems.

Pizhichil (literally meaning squeezing) is a unique Ayurvedic therapy from Kerala. In this treatment, a special linen cloth is dipped into warm Kuzhambu, or a medicated oil mixture, and squeezed over the disease-affected areas of the patient. While simultaneously massaging those areas, care is taken to ensure no portion is missed out. Pizhichil is a perfect mix of Snehana (Oleation Therapy) and Swedana (Sudation Therapy). This treatment improves blood circulation and immunity. It is very effective in the treatment of ailments like muscle cramps, paralysis, rheumatic diseases, arthritis, neurological disorders, and blood pressure issues. (276-277)



Fig.40. Shirodara treatment

**Tibetan medicine,**

With a history going back to the ancient cultures approximately 2,500 years, the Tibetan medicine, known as Sowa Rigpa in the Tibetan language, is one of the world’s oldest known traditional medicine. It originally developed during the pre-Buddhist era in the kingdom known as Shang Shung. Practitioners of the Bön Shamanistic religion recorded formal texts describing healing rituals, medical divination, and astrology. Practices such as medical divination lead to much the same nature of treatment. A divination would be made indicating a particular elemental disturbance and a ritual remedy prescribed. Divinations would not be limited to medicine but were connected to all actions considered important, such as marriage, beginning a business, and funerals.

 The Tibetans had their own medical system before the arrival of Buddhism. It used herbal remedies, poultices and Bon shamanic practices and rituals to cure people. King Songtsen Gampo took two Buddhist wives and introduced the religion into his country in the year 641 C.E. and he welcomed many masters and scholars of Buddhism from India and China. These masters did not dismiss the native traditions and deities but integrated them into Buddhism. The same process occurred with the native medical system and those of India and Tibet. The next King, Trisong Deutsen organized and international medical college. He invited doctors from Nepal, Greece, China, Persia, and India. From this sharing of knowledge, the Tibetan doctor Yutok Yonten Gonpo created the Four Tantras.

    The historical Buddha, Siddhartha Gautama, talked about his role in medical terms. He is known as the supreme physician. His teachings are intended to cure suffering. His first teaching, known as the four noble truths, is given in a traditional format of Indian medical diagnosis. This format is to first state the problem or disease, then state the cause of the disease, then state if the disease can be cured or treated, then finally state the cure or treatment of the disease. The Tibetan doctor is imitating the Buddha’s path and being a doctor is considered a spiritual path in itself.

The traditional Tibetan doctor starts out his day with a specific meditation. He visualizes himself as the Medicine Buddha. The Medicine Buddha wishes freedom from suffering for all. Through the power of his realized mind, Medicine Buddha diagnoses the illness as symptomatic of fundamental spiritual disharmony caused by ignorance which is a lack of understanding the basic nature of reality. By visualizing themselves as Medicine Buddha, doctors of Tibetan medicine pursue an aspiration to develop the same capacity for compassion, awareness, and skillfulness. This process is the root from which diagnostic skill develops.

  The core texts of this medical tradition are known as the four Tantras. The first Tantra also known as the Root Tantra. It contains six chapters and is outline of the other six texts. Using the metaphor of a tree they categorize the Root Tantra categorizes into three roots, which divide into nine stems, which divide into 47 branches, the forty-seven branches hold 224 leaves. The second Tantra diagnosis techniques, including pulse diagnosis, tongue diagnosis, and urine analysis. The third tantra contains information on treatments, diet and behavior modification. The fourth Tantra contains 27 chapters and contains more information on diagnosis, information how to make and use medicinal pills, information purgatives and other treatments that are used as a last resort.

   The basic understanding of human physiology in Tibetan medicine is based on the Ayurveda.  The roots of Ayurveda are in the Artharva Veda . The famous physicians the Ashvins were known for surgery, treating paralysis blindness and even replaced the lost limb of a soldier with an iron one. In the beginning, Ayurveda was inseparable from religion and magic. Atharava Veda is the earliest source of therapeutic prescriptions that began the Ayurvedic tradition and equates disease with the influence of demons. It prescribes magical and herbal medicine, a variety of plants, charms and incantations-to ward off the evil spells of demons and enemies and to improve health and sexual vigor.

Ayurveda was divided into eight branches. These were surgery, disorders of the head and neck, general medicine, psychiatry, pediatrics, toxicology, rejuvenation, vilification. The rational view of disease that developed was based on the three humors ( air, bile, and phlegm), which are the underlying constituents of the body, “not just airy, bilious and mucous matter found in the body but three principles of life energy”. By the 13th century Moslems had conquered or raided most of India and destroyed what every trances of Buddhism they could along the way. Tibetans could no longer go to India for medical teachings or text but they connected the Indian theory of the three humors and the five elements to the Buddhist idea of the three poisons that are considered to be the root of all suffering. The three emotional poisons ( ignorance, desire, and hatred or aversion) central to Buddhist theory of suffering and liberation, are considered the root cause of all diseases. These poisons effect the health of the body through the wind element. This is the not wind as we normally think of it, though that is one of its manifestations, rather it is the subtle energy in India, known as prana, which connects the mind with body.

  In Indian mythology, medicine was first discovered by the god Brahman and then passed to the Ashwin twins who passed it to the king of the gods Indra, who taught it to a human named Atreya, who taught medicine at the city of Taxila. The theory of the humors starts with the void or Dharmakaya, what Hindus call Brahman. This void mysteriously becomes two creating duality that takes the form of the mind and consciousness and five elements. For Buddhist and Hindus , the mind is considered to be the base of all existence, the creator of all phenomena both internal and external. The mind combines the five elements into various forms and relations, that create energy.

The mind and the five elements divide the energy and gross material they have created into three categories body, energy, and mind. In the human body they become Wind, Bile, and Phlegm respectively. The human body is seen as composed of five elements that combine to form the humors. Their relation to each other is responsible for all bodily functions and when they get out of balance is when illness occurs.

The three humors are Lung or Wind, Tripa or Bile, and Phlegm. Wind is responsible for all the movements in our body, blood circulation, nerve impulses, and our thoughts. Bile is responsible for our metabolism, liver function, vision, and discriminating intellect. Phlegm is responsible for the initial stages of breaking down food, the bodies lubrication, fluids, our will, and memory.

In addition to balancing the humors themselves, there are other aspects of the body that must be balanced along with them to maintain health. The balance or imbalance of three classifications 1) humors, 2) constituents, and 3) excretions that cause the body to thrive or to be overcome. There are three types of excretions; urine, feces, and perspiration. There are seven types of constituents, known as the supports of life; food, blood, flesh, fat, bone, marrow, and semen.

 Buddhism has been intertwined with medicine from the very beginning. The Buddha knew Ayurveda very well and gave his first teaching, in the form of a traditional medical diagnoses. He even gave medical prescription to be given to ailing monks. In the medicine section of the Vinaya he noted that certain foods, such as honey and butter, should be taken as medicines by the monks; he prescribed many different vegetable, animal, and mineral substances as remedies for ill monks.”

 The Hinayan tradition contains advanced anatomical knowledge that arose from the practice of meditation in cremation and charnel ground ,more specifically from examining and meditating on dead bodies as a form of meditation on impermanence and interdependent origination. The meditation was used to incite disgust with the human body in the meditator as a way of reducing his sexual desire. In the Vajrayana, the highly developed external cosmology of Mahayana, Buddhism became internalized as the human body came to be seen as a microcosm of the universe. From the psycho-physical practices of these tantric yogis arose a separate category of healing known as Tantric medicine.

  Indian alchemy is related to both tantra and medicine. From it arose another medical tradition known as siddha medicine. “The goal of this form of medicine is to transmute the body and make it “immortal by the use of medicinal and magical herbs and substances. These are applied in conjunction with religious techniques like mantra and incantation. In this way, the elements in the body become purified and transformed into their subtle counterparts.”  The main substance for this form of medicine was mercury. Much of the effort of the siddhas was in transforming mercury from its toxic liquid form to healing solid or fixed form. “ mercury was like the mind: by nature, unsteady; but when stabilized, there was nothing in the world that could not be accomplished. The alchemical formulas became a regular part of Tibetan medicine. The Tibetan system of elixirs and essence pills relied on the purified or fixed from mercury that the siddhas developed.

Tantric medicine is the bridge between the rituals and spiritual practices of dharmic medicine and medicinals and acupuncture of somatic medicine. The template of our actual embodied existence with its three aspects-mental subtle, vital, and physical and for the three kinds of Tibetan medicine-Dharmic, tantric and somatic. Tantric medicine deals with the winds channels and essences. It manipulates them through mantra and visualizations to heal the physical body. These winds and channels are the subtle body which manifest out of the voidness of the Dhamakaya and support for the physical body. Illness occurs when there is a blockage in the flow of this subtle energy system. The overall picture of Tibetan Medicine is an interwoven expression of non-linear, triadic relationships linking the spiritual, psychic and physical life of the individual and the universe. In Buddhist Tantric medicine, the entire universe is seen to be within the individual. Tantric medicine uses the vital psycho-physical energies of the internalized universe as a means to transforming the outer universe.This is the inverse of the use of mercury in siddha medicine. In siddha medicine the external elements are used to transform mercury which is then applied to the body as a way to effect the winds and the mind and transform the body and improve health and concentration.

   A number of treatments and modalities are used to manipulate the subtle energy in tantric medicine. Mantras are prescribed by the doctor and said by the patient to adjust the vibration of the subtle body and undo blockages to allow one to tune into their inherent Buddha nature. Another technique is to visualize various colors of light emanating from a deity and entering the ailing part of your body and purifying it. Jewels are also used to adjust the frequency of the subtle body. Massage and acupuncture also use the channels and winds to effect healing in the physical body through the subtle body. Breathing exercises are used to strengthen the subtle body and clear blockages from the channels. Tantric mystic physiology of the subtle body is directly related to the somatic physiology of regular medicine and the tantric practices of manipulating it bear directly on tantric healing. For example, the system of subtle veins and pathways are the channels used and manipulated in Tibetan acupuncture and moxibustion.

The five elements connect the microcosm and the macrocosm . Both the internal subtle body and the external world of gross material world are made of five elements. This links the subtle energy practices of tantric medicine to the more physical practice like herbal medicines. Both diagnoses and medicines are classified according to the three humors and the five elements. It starts with inhaling incense as means of delivery and works up through herbal baths, medicinal oils, and the ingestion of various herbal preparation. Moxa, blood, letting and acupuncture are seen as extreme forms of treatment as a last resort.

 Every aspect of living such as environment and weather can throw the three humors out of balance. Too much or too little of anything can do the same, such as too little food, too much physical labor, or too much thinking. The factors that can throw one out of balance are divided into two main types, called primary and secondary causes. The primary causes are the negative emotions, such as anger, aggression, lust, desire, and ignorance. The secondary causes repetitive patterns in lifestyle, behavior and diet, changes in the weather and d the seasons, and other outside provocations such as spirits.

 The methods of diagnosis are divided into three categories. They are Inspection, Palpation, Anamnesis. Observation includes all aspects of a patient’s behavior and appearance including things like analysis of the urine. Palpation refers specifically to pulse diagnosis Anamnesis is the case history and includes the answer from all question asked of the patient about such things as diet, lifestyle, and emotional states. Healing methods are divided into four categories. These are therapeutic diet, modifications in lifestyle, medication, application of external therapies, these are cupping, bloodletting, compresses, and stick therapy. There is also a fifth category according to the terms or treasure tradition. This fifth category is mantra healing. Mantras can be used with of the other modalities of healing or they can be used example independently. When used in conjunction with another healing modality it enhances the effects of the treatment method being employed. During the compounding traditional of Tibetan medicines many healing mantras are recited, incorporating the energy of sound into these complex combinations of herbs and minerals .

The Tibet medical system gives advice about the process of dying from a subjective point of view as well as the state in between bodies before rebirth called the bardo. According to the Tibetans, both in medical and religious theory, what happens during death is this. First, the five elements making up the physical body dissolve, and the consciousness is released into space. Second, one either recognizes the luminous nature of the mind and reality as voidness or if not, one experiences a variety of hallucinations and is directed by the force of karma into pleasant and unpleasant experiences (experienced with the mental body as being real-the way the mind experiences a dream) until finally takes rebirth. In the womb, one has a variety of conscious experiences before birth. At the time of death first the five elements dissolve one after the other in the order first earth, then water, then wind, and finally the consciousness dissolves into space. Each of these stages are described in detail in the Tibetan book of the dead. It is considering important to know this so that one can easily recognize the stagers of death as they are occurring so as to remain unafraid. It is important not to be overcome by emotion, so as to avoid confusion while dying, so that one may recognize one is in the bardo and then guide one’s consciousness either to enlightenment or a better rebirth. For tantric practitioners, the exact time of consciousness dissolving into space is of highest importance. This is because at this moment space is revealed as the pure light of consciousness also known as the Dharmakaya reversing the process of creation. If one is able to remain conscious at the moment of death and recognize the Dharmakaya for what it is one achieves Buddhahood instantly. Tibetan medicine considers it important that the dying person not be under the influence of strong drugs or pain killers because it can interfere with the ability of a person’s consciousness to recognize the clear light at the moment of death. If one does not recognize the clear light one enters the bardo.  The Tibetan book of the Dead is read in the presence of the dead person’s body because it is believed that he can hear the recitation in his mental body. The book entail guides the person through a series of visions the person’s mind will have between death and rebirth. It continually reminds the practitioner to recognize what he is experiencing are projections of his own mind, if he recognizes this fact his consciousness can become enlightened.

  Eventually the consciousness merges with a body. The mental body sees various images of beings copulating, his karma attracts him to a particular couple and he enters a womb. At this point the process of being reborn in a physical body has begun and from the Tibetan medical perspective it is time to consider the relationship between the mother and the fetus. The diet and psychic/emotional relationship with the developing fetus is considered very important during pregnancy. The fetus is considering a conscious person and it is said “the consciousness of the fetus, grieved by the state of dirtiness, stench, darkness, and imprisonment, conceives the idea of escaping. Every aspect of life is seen as filled with suffering.

   Tibetan medicine has an extensive pharmacology and these medicinal substances are divided into eight categories. These are gems and metals, substances derived from rocks and minerals, medicinal earths, exudates and secretions, medicinal substances obtained from trees, medicinal substances obtained from the boiled extracts of various plant parts, medicinal plants, herbs and grasses, medicinal substances obtained from sentient creatures. These substances are also categorized and arranged in a medicine mandala. Like any mandala, it contains a center and the four direction; east, south, west, and north. In each direction is a medicine mountain which contains medicines to treat a specific category of disease. “The four medicine mountains of the mandala provide treatment for hot disease; cold diseases; all diseases; and maintenance of the six vital functions and organs. These four divisions of medicine, which can be further reduced to two, preventative and curative, are a miniature model of the larger medical system. The mountains of every direction are said to be planted with medicinal herbs by the medicine goddess Nectar Mother or Yitogma.    In the eastern direction is the mountain known as Fragrant Mountain or Ponadan. It is a mild jungle climate which contains the medicine known as the supreme medicine, myrobalan , which is the plant that the medicine Buddha holds in his hand. Myrobalan has all six tastes and all eight powers of Tibetan medicine. Its perfume drives away all four hundred and four diseases. This is the category of medicinals that treat all diseases.

   The “Cool Mountain” or Malaya is in the west. This is the category of medicine which is for the maintenance of the body. These are divided into six: Nutmeg for wind, clove for the life vein in the heart, cubeb for the spleen, cardamon for the kidney, saffron for the liver, bamboo pith for the lungs. This mountain also contains the medical minerals, metals and gems. “In the rocky parts of the mountain are found five kinds of pitch-gold, silver, copper, iron, and lead-which are good for fevers. Five kinds of quartz are also there, and five kinds of medicinal hot springs. The springs coming from coal are good for fever; from coal and sulfur are good for cold diseases and disordered fluids; from coal and pitch for bile diseases, act. In Tibet, there are many kinds of hot springs and the Tibetan medicinal use of thermal springs was an entirely indigenous development. Also contained in this mountain are medicinal animals and gem stones such as turquoise which is said to be good for all diseases.  In the north is the “Snow Clad Mountain” or Gangchen, which is said to have the nature of the moon. Being a cold place, it grows medicine that are good for hot diseases. Here grow many fragrant substances that are used in medicinal incense such as sandal wood, camphor, and aloes wood.   In the South is “Thunderbolt Mountain” or Begche. It is said to have the nature of sun and grows medicinals good for treating cold diseases. These include black pepper, long pepper, and pomegranate. In the center of the mandala sits the Medicine Buddha.

  Very important in the gather, preparing and use of these substances is the state of mind off the doctor or herbalist. The main thing is that one should not make medicine without utter and complete devotion to the guru and to the Medicine Buddha. Without demonstrating devotion of this kind, one will not even be able to receive medicine teachings. Tibetan doctors are not interested in telling their secrets or convincing anyone. They are interested in maintaining a pure samaya (tantric vow) with the Medicine Buddha, for from that comes all medicine power. The doctor must be aware of soil and weather conditions when going to collect medicinals and how these effects the predominate element in each plant. When gathering these herbs, he must be mindful to regard himself as the Medicine Buddha and the plants he is gather as the mandala of the Medicine Buddha. He must maintain this mindfulness while cleaning and measuring the medical substances. This is to be done with grace and skill and even the arranging of the substances on a plate is to be seen in terms of creating a mandala. The actual preparation of medicine is to be accompanied by prayer and even substances such as feces are to be viewed with the pure perception of a Buddha, meaning that they are not to be thought of as vile or disgusting. No matter how long the process of preparation, once begun it must be completed without taking any breaks. On top of this no negative emotions, such as boredom should be allowed to arise during the process.

The Bon religion, aka Yungdrung Bon, is one of the oldest religions in the country, with its origin believed to date back to the pre-Buddhist period. It is an animistic religion that mainly worships natüre. The practitioners of the Bon religion believe that its origin is in Zhang Zhung, which is located in the Himalayas near Mount Kailash. According to ancient texts, the religion was split into two primary categories, black and white. These opposing forces of light and darkness gave birth to two persons initially. On the one hand, the black man often referred to as Nyelwa Nakpo ("Black Suffering"), is said to have created all the stars and demons and to be the cause of evil occurrences like droughts. On the other hand, the white man Serden (also known as "Radiant One") is a kind and honest individual. He created the sun and moon and introduced religion to humankind. These two opposing forces are still engaged in a war within each person's heart as well as in the sphere of good vs. evil. The white part, which was primarily centered on nature worship, included a variety of rites and offerings made to spirits and deities thought to live in nature.  The black part was more focused on shamanism and was used to communicate with the dead, ask for guidance and protect against evil spirits.The Bon religion is an ancient religion that has been practiced in Tibet and Nepal for centuries. Its core beliefs focus particularly on the three jewels: body, speech, and mind. It also believes that individuals are composed of five elements: earth, water, fire, air, and space. These five elements interact with each other to bring about positive transformation. The cosmic egg that formed the entire universe is said to have formed from these elements and all life is considered holy and intertwined in the Bon religion. People must try to maintain the environment and the community in harmony. The dead and their ancestors are held in high regard. Every day, practitioners pray, chant mantras, and make offerings to the gods and spirits. Afterlife and karma are important concepts in the Bon religion. Individuals will experience many life cycles before attaining enlightenment. Practitioners use ceremonies, meditations, and pilgrimages to enhance their spiritual power The Bon religion teaches non-violence and tolerance for all living creatures. Respect for nature is seen as an important part of maintaining balance in the universe. This faith does not recognize any other religion as superior or inferior to itself, which promotes harmony among people of different backgrounds.Depending on the region and tradition, the Bon religion is associated with various practices. Offering sacrifices and incantations to gods and spirits are common Bon rituals, as are meditative practices such as visualizing divine beings and communing with them. Weddings, funerals, and divination may require the services of Bonpo priests who also work as healers or shamans, diagnosing and treating illnesses with methods such as divination, herbs, and mantra recitation. Shamans can provide spiritual advice and healing in addition to physical ailments.

Tantric rituals involve drawing mandalas and chanting mantras. Bonpo followers aim to achieve spiritual enlightenment and awareness to learn more about themselves and the world around them via their rituals through tantrism, prayer, or meditation.One of the key aspects of Bon is its belief in multiple gods and spirits. There are hundreds of gods, goddesses, and spirits in the Bon religion. Four major enlightened beings Satrig Ersang, Shenlha Okar, Sangpo Bumtri, and  Tonpa Shenrab Miwoche.are worshiped by Bonpos. Satrig Ersang is known as the mother and means wisdom. One of her incarnations is called Sherab chamma (the loving lady of wisdom). The chants related to Satrig Ersang are SRUM, GAM, RAM, YAM, OM, and her color is yellow. Shenlha Okar is known as the wisdom priest of white light. He is believed to have created the universe and all living things, and he is the source of knowledge and spiritual power. Dharmakaya is considered to be a  deity who is the consort of Shenlha Okar. Sangpo Bumtri is known as the procreator with no hands, ears, eyes, or nose because he only has a spirit. He is said to bring all the beings to the earth. He is known as the creator god of the Bon religion. Tonpa Shenrab Miwoche is known as “the teacher” or a great priest. He is associated with Niramankaya, who is supreme. He is considered the present teacher of Bon's religion. Bon believers additionally believe in a variety of ghosts and demons, which are considered to be accountable for misfortune, illness, and other sorts of misery. It's thought that these ghosts and demons have the power to possess individuals and make them perform terrible things. Bon followers perform rituals and rites to satisfy the ghosts and demons in order to defend themselves from harm. The Bon religion of Nepal is an ancient belief system that has been practiced for centuries in the region. It is thought to predate Buddhism, making it one of the world's oldest spiritual traditions.

The Bon religion, which has a sizable following among Tibetans, is still followed in Nepal. Tonpa Shenrab Miwoche is the sole source of knowledge and wisdom for humanity. Truth and justice come from him, and he is the one to seek if one wishes true freedom. Knowledge, understanding, compassion, and wisdom are considered to be the four pillars of the spiritual journey. Bon philosophy places an emphasis on spiritual salvation and sees the earth as a place of suffering.   Numerous ceremonies and issues are practical and worldly, such as ransom rites to appease local deities and divination practices intended to transport the spirit of the deceased to astral planes. As a traditional medicine, Tibetan medicine has been recognized as a popular and viable healthcare option providing an alternative clinical reality. Its inherent ability to incorparate predictive diagnostics, targeted prevention, and the creation of individualized medical treatment give Tibetan medicine great potential for assessing and treating patients. Tibetan medicine is an intricate medicine with a long history of treatment effectiveness. The indigenous cultures of pre-Buddhist Tibet also included the use of natural herbal remedies. In particular for wounds, very common when living in harsh environments, various poultices and wraps were used. These basic treatments formed one branch of medicine that when combined with Bon ritual practices offered its people relief. The shamanistic practices, although often relying upon what can be described as superstitious beliefs, also put emphasis upon personal meditation and the balancing of one’s body both internally and externally. It is precisely this notion, of the relation of mind and body, that would continue to develop with the introduction of Buddhism into Tibet.

Tibetan medicine employs many methods to diagnose disease and imbalances. The first and most important aspect is to discover the individual’s humoral constitution, that can be determined as early as infancy. One’s humor is determined by the diet and behavior of a child’s mother during pregnancy. The three humors are rlung (wind), mkhris pa (fire), and bad kan (earth and water). Differences between the three include for example body type, head shape, digestion, sleeping patterns, and emotional expressions. Each humor pre-disposes the individual to various diseases. For example those with the mkhris pa (fire) constitution are pre-disposed to skin diseases, rashes, and infections. Thus appropriate targeted prevention can be taken predicting diseases before they arise and subsequently avoiding them.Regarding specific diagnosis, digestion is a main focus of Tibetan medicine. The way one digests gives valuable advice to imbalances in the body. Tibetan medicine considers an imbalance in any organ or part of the body to primarily (other then injury, etc.) caused by first an imbalance in digestion. For this reason each individualized medical treatment always incorporates herbal formulas, diet, behavior, and external treatment that directly intend to bring balance and health to the digestive system. During a Tibetan medicine consultation the doctor checks the patient’s pulse and urine. Pulse can show the individual’s humor, and specifically can diagnose imbalances in each organ. Urine has 9 aspects used for diagnosis, for example color, bubble shape/formation, sediment, film, and smell. Each aspect can hold keys for diagnosis. The doctor checks one’s response to treatment and adjust as needed. In Tibetan medicine there is no complete cure. The doctor treats the patient by creating long term plan. For chronic diseases treatment may last many months to years. At every step of recovery the doctor works closely with the patient and his or her community to support balance and health, in addition to herbal remedies, prescribe meditations or advise exercises such as Tibetan Yantra Yoga. The Gyushi (Rgyud bzhi). or Four Tantras, is Tibetan medicine's most enduring foundational treatise, dating back to the twelfth century. The remained core text describes the body in its interaction with the five elements (water, fire, earth, air, and space), the three nyepa (humors) seven bodily constituents, and the digestive heat are the fundamental principles of physiology.and the environment. The body is seen as in constant flux between the nyepa and the elements, demanding an approach to health that includes dietary and behavioral adjustments and an interconnected understanding of how medicinal substances and foods within one's climatic environment affect the body within this dynamic.

The primary imbalance that leads to ill health is seen to take place in one's mind. The secondary causes are due to imbalances of one's food and behavior and climatic, spiritual, and planetary surroundings and influences. The classification of illness follows a four-fold scheme. In Tibetan medical texts, 404 diseases are mentioned: 101 are karmic diseases caused in this lifetime by spirits (these diseases include many neurological diseases) and inadequate diet and behavior, are fatal without medical and spiritual treatment; so they need medical treatment and spiritual treatment, such as rituals; and by changing food habits and lifestyle. Physicians focus not only on their patients' symptoms but also on their diet, behavior, climatic exposure, emotional patterns, as well as on detecting illness in the rhythm of their pulses. This complex approach can be considered an art, and the physicians as artists. Tibetan physicians seek to develop unusual sensitivities in their fingertips to feel and analyze the various rhythms of the pulse and cultivate a sensitive tongue to taste the six tastes and potencies of raw medicinal ingredients. Touch and taste are at the basis of their medical art. The diagnosis of illness in Tibetan medicine is approached through three methods: questioning (asking the patient), feeling (pulse diagnosis). and seeing (observing urine, tongue, eyes, and skin). These three sensory faculties require specific training and refinement in order to become tools of diagnosis. The Tibetan term tsa tawa (rtsa Ita ba), "feeling the pulse," ,is a general term for all types of channels, including wind channels or tsalung (rtsa rlung), which are subtle in nature and the carriers of consciousness . The verb tawa (Ita ba) means to see, to look, or to investigate in a broad sense, and describes a process of intuitive comprehension.Complex Tibetan sphygmology is mastered only through many years of practical application and experience.

The pulse is felt at the radial artery on both wrists with the physician's right index, middle, and ring fingers being placed on the left wrist and vice versa. The pulse is considered a "messenger between the physician and the disorder," and its twelve organ pulses "beat separately without being mingled." A Tibetan physician feels two different organ pulses under each finger and based on the pulse speed determines whether the disorder is of cold or hot nature. The Four Tantras outlines the ideal circumstances "early in the morning, when the sun has risen in the sky, and the sunbeam has not fallen on the plain; the internal breath is not exhaled and the external cold air not inhaled;one has not moved from one's bed, and not eaten anything." under which the pulse should be felt for diagnosis. In addition to the organ pulses, there are seasonal, constitutional, and life-span pulses allowing for the diagnosis of seasonal changes of nyepa imbalances, healthy constitutions, indications of the lifespa n and difficult years in the patient's life, as well as other divinatory and prognostic information.Tibetan physicians must identify a disease according to hot and cold categories in order to determine the appropriate treatment, which is allopathic in nature- hot diseases, are treated with cooling foods, medicines, and therapies, and vice versa. Pulse diagnosis remains the main diagnostic method of each medical encounter. For severe cases, including chronic arthritis, external treatments such as moxibustion or golden needle therapy are performed- burning moxa (cones of dried artemesia leaves) on specific points on or near the skin or through a golden needle that is shallowly inserted at the top of the cranium.

Tibetan physicians use the duration of their own breath while feeling the pulse to determine w hether an illness is hot or cold. "the normal pulse rate is five beats during one respiratory cycle of the physician A pulse rate of six beats and more per respiratory cycle indicates a disease of hot nature , a pulse rate of four and lower indicates a disease of cold nature."Medical observation includes looking at the coating of the tongue, the coloring of the sclera, and the protrusion of blood vessels in the eyes. Questioning the patient on symptoms, diet, and behavioral patterns offers clues on nyepa imbalances. Tibetan medicine is a medical system that focuses on the individual constitution and nyepa imbalances rather than on a disease category leading to the assumption that the medical encounter itself is an expression of individualized patient care. During a typical consultation , the physician feels the patient's pulses at both wrists, look at the tongue, ask key questions about symptoms and complaints, and write a prescription for various medications. Prescriptions are periodically adjusted and changed depending on pulse diagnosis and fluctuation of the nvepa.

Cupping is also practiced widely in Asia. It is easy to perform and used to treat chronic rheumatic and arthritic disorders. Tibetan massage, or kunve (bsku mnve) is especially beneficial for lung disorders. The art of Tibetan pharmacology involves the development of the sense of taste by pharmacologists and physicians. The tongue is considered a kind of laboratory, detecting the finest nuances of six tastes (sweet, sour, salty, hot, bitter, astringent) and analyzing medicinal qualities through them. Some of the purification methods for certain ingredients take several months and involve complicated alchemical processes. Tibetan medicine, uses divinations as ritual healing practices to subdue spirit influences and negative karma . People take Tibetan medicine regularly as tonics on astrologically calculated auspicious days . Tibetans know their favorable "life-force days" and "life-essence days" and mention them to the Tibetan physician to schedule the most auspicious day for external treatments.

Tibetan Tantric conceptualizations of body and mind tend by comparison to be less rigid and less dichotomized. In the Indian Tantric (Vajrayana) context as transmitted to Tibet, there is frequent reference to the "Three Vajras" or "Three Gates," meaning body, speech, and mind. While these imply an analysis into three components, the emphasis is more on three aspects of a single human organism to be worked with and perfected in Tantric practice. Tantric practice engages the body through posture and through chaggya, or hand-movements (phyag rgya; Skt. mud chaggya, or hand-movements (phyag rgya; Skt. mudra), as well as through physical exercises and practices. Speech is involved through the recitation of mantra and liturgical text, and the mind through visualization or creative imagination and other exercises at the level of consciousness . The human organism is a unity. It is not separate from its environment, since all aspects of the organism are part of the universal process of dependent origination, or tendrel (rten'brel; Skt. pratltyasamutpada) by which all phenomena arise in dependence on each other.

"Mind" can be a deceptive term, since it tends to privilege the cognitive and rational aspects of consciousness. The English word "mind" does not map closely onto any single Sanskrit or Tibetan word. Mind in the triad of body, speech, and mind is in Tibetan yid (ཡིད) or its honorific thug ( འཐེན་ཐུག་), corresponding to Sanskrit manas. (yid Tibetan; in Sanskrit: manas) refers to the “the activity field of the intellect” [=yid-kyi skye-mched].Like the other common Tibetan word for mind, sem (sems; Skt. citta), yid includes volitions (intentions) and emotions as well as reasoning and perception. Mind is not concerned purely as a cognitive process, better translated as "heart-mind" ( Yid, thug) and sem overlap with another term, "namshe" (rnam shes; Skt. vijnana). This term is translated into English as "consciousness" and represents the aspect of the human organism that continues between one life and the next, carrying the karmic impressions of one life on to the following one. 'mind' and 'heart' both translate the same Sanskrit word (*chitta*),thoughts and feelings are inextricably linked and exist on a continuum. The center of our individuated consciousness is 'heart-mind' (*chitta*), in which vibrate fluctuations (*vrtti*s) that can be more rational and linguistic (thoughts) or less linguistic, less rational, and more charged with affect ( emotions).

This heart-mind has three primary aspects, in the Indian model: a faculty of attention and sensory processing (*manas*), an identity-maker or self-image former ( called "ego," *ahamkāra*), and a capacity for imagining things, for forming judgments and making decisions (*buddhi*). Tantric practice is more concerned with the interrelationship between heart-mind, or consciousness, and the material level than with analyzing them separately. It is taken for granted that the relationships between them mean that a form of spiritual practice that works at both levels (or all three, if speech is included as a separate level) is likely to be more effective than one that operates only at one level. Much Tantric practice involves the assumption of flows and connections between the practitioner and the wider environment, often visualized and experienced in the transfigured form of the Tantric mandala. When the practitioner visualizes himself or herself, in a sequence that forms part of most Tantric practices, as a Tantric deity at the center of a mandala, the aim is to become one with an enlightened form that transcends the mind-body field of the individual an aspect of ultimate Tibetan reality.

**Channels and Cakra: The Subtle Body in Tantra**

Within that mind-body field, the so-called subtle body has an important place as a way of grasping and operating with the connections between the physical level and that of mind or consciousness. The term "subtle body" is used in a general sense to cover the idea of a level of presence and structure within the human organism that is thought of as being beyond the immediately material and physiological, not immediately perceptible to an external observer, but in some sense between the level of physical materiality and that of consciousness. The subtle body has similarities to the speech level in the triad of body, speech, and mind, in that it is posited as being in some way intermediate between mind and body. Properly speaking, the term "subtle body" originated as a translation of the Sanskrit name for one of the concepts, the stJksmasarTra of Vedanta philosophy. In its later usage, this Within the Vajrayana tradition, the subtle body, as the intermediate structure between mind and body, is closely related to speech in part via its intimate connection to the breath. The quasi-material substance that flows through the channels and cakra (tsa and khorlo) of the subtle body is an internal correlate of the breath or lung (rlung; Skt. prana). The flow of lung is commonly described as the horse or vehicle on which mind or consciousness rides. This implies the importance of controlling and regulating lung prana, or inner wind, if one is to be able to direct and control mind or consciousness.

A tradition of exercises known as trulkhor ('khrul 'khor or 'phrul 'khor), combines both physical movements and breathing A version of these exercises is depicted in the early eighteenth-century murals of the Lukhang (Kiu khang) Temple in Lhasa . The internal flows of lung are thought of as closely related to physical breathing. Equally, when the flow of lung is disturbed, this can lead to disturbances in consciousness. Thus working with the tsalung- channels and inner wind of the subtle body is a key component of Vajrayana practice. Both men's and women's bodies contain both male and female thigle, which are further associated with bodhicitta, the compassionate motivation to free all beings from suffering that is the essential motivating force behind the attainment of buddhahood. Emotion, volition, and cognition merge into a single set of integrated concepts. Birth and death are also linked with specific processes within the system of channels and wind. The subtle body provides a central model for understanding the relationship between body and mind, the processes of birth, life, and death, and the progress toward the central Buddhist goal of buddhahood, bodhi, or awakening. At the time of dying, the inner lung associated with the four elements- earth, water, fire, and air- dissolve in turn. Earth refers to the hard and solid aspects of the human organism, such as bone; water to the fluid components; fire to inner processes such as digestion; and air to the system of inner winds or lung as a whole. As this process takes place, the various kinds of sense consciousness associated with each element also cease to function, since their supporting winds are no longer present, and the corresponding sensory capacities and forms of awareness are also lost.

The longevity attainment practices, or tsedrub (tshe sgrub), involve the emanation of the visualized world of the deities and the Tantric mandala from seed-syllables imagined at specific points in the subtle body (most often at the heart-center cakra, though other cakra may also be involved), and a variety of other elements that are premised on the structure of the subtle body. The stages of dissolution and the associated rituals suggest some of the relevance of the subtle body to medical concerns. The subtle body is integral to the ways in which birth and death are understood. Imbalances within the subtle body can lead to wider disorders in the organism, particularly certain kinds of psychiatric illness. The physical and internal trulkhor exercises are premised on the subtle body, as are the Tantric health-giving practices of longevity attainment. Tibetan medical scholars aimed to systematize the understanding of how medicine and healing operated and to develop effective treatments basing their writings largely on their own experience in clinical practice, a form of nvamvig (nvams vig, writing from experience), rather than simply on their understanding of the Four Tantras or other texts This emphasis on clinical practice meant that many Tibetan doctors became devoted to practical observation. The development of the Gyushi-based system of Sowa Rigpa, or Tibetan medicine, whereby moxibustion became an integral aspect among the four main therapy options of a physician - diet, behavior, medicines, and external therapies. The knowledge and practices in the wider theoretical framework are outlined in the four volumes of the Four Tantras (Root Tantra, Explanatory Tantra, Instructional Tantra, and Last Tantra). Over the centuries the Four Tantras became a standard medical treatise in Tibet, the Himalayas, and Mongolia, and many commentaries and much of contemporary Tibetan medical practice still revolve around it

In fomentation, or dug (dugs), medicinal substances are applied either as raw materials or poultices, which are placed on a point of pain or an area linked to a particular disease. According to the nature of the disorder, either cooling or warming fomentations are used. Cooling fomentation relies on cold substances or objects, such as water, ice, water stone (chu rdo), a water bottle, wet clothes, iron, or clay. the Four Tantras prescribes fomentation of "stargazing" water, or karchu (skar chu) .To relieve pain caused by a cold (cham pa), disturbed fever, spread fever (tsha ba byer ba), or chronic fever (rnytng tshad), karchu spraying onto the face, head, and shoulder of the affected person is instructedi. For swellings of the eye or face, as well as bruises and general swellings, cold water or a piece of cold iron should be applied, such as the tip of an iron plow (thong lcags) or a spade. To heal diseases that attack and block the throat and are caused by poisoning from meat, a mixture of powdered white aconite (bong nga dkar po) and snow water is indicated. This mixture is put into an animal bladder or on a clean cloth and then applied to the throat. For colic pain, white aconite and zhu mkhan are combined with cold water before application. Different kinds of cold fomentations to be placed on particular locations or painful parts of the body are explained in the Last Tantra.

In warming fomentation, heated substances such as salt or sand, stones, water bottles, toasted grains, good quality herbs of warming nature, and soil are placed on body parts to stimulate them, increase the body's heat and metabolic force, and/or remove cold diseases. Among the twenty-one warming fomentations described in the Last Tantra, For indigestion and colicky abdominal pains (derived from "cold bile" and "bile phlegm"), salt or salt packages that have been heated in a pan are placed on certain parts of the body. Against "wound blood stagnation" caused by injury, internal bleeding, or injured channels, "dark water stones," which have been collected from waters that are always in the shade, are warmed up in fire (to extract all humidity from them) and then applied to the affected area. For "liver blood stagnation" (mchin khrag 'khvags pa), warmed-up moss (grog shing) mixed with toasted barley (vos) is used.

"Cold kidney" pains and urine retention should be treated with dried cow dung (lei ba), first warmed in a pan over fire then put in a cotton bag before application. After childbirth, for post-delivery pains in the lower abdomen, hips, and area of the kidneys, fomentation should be prepared with soil found in a mouse hole facing east (bvi khung shar bltas sa) that is mixed with chang, warmed by fire, and applied. All these substances are in everyday use in Tibetan and Himalayan areas and easily and freely available in any part of the country. Many people, especially Tibetan women, in remote areas where doctors are often unavailable know about such therapies as a way to alleviate common aches and pains. Therapeutic use of water is widespread among Tibetan people in the Tibetan medicine tradition Different types of drinking waters such as hot springs, or chutsen (chu tshan), special cold showers (chu vi 'khru/ 'khor), and medicated baths (lums) and hot thermal baths are widely commented upon in the medical tradition, owing to the cold climates where Tibetan medicine initially developed and practiced.

Tibetan physicians have classified the different characteristics of the waters and their effects on various disorders, according to the presence of different combinations of mineral stones in the immediate vicinity of the springs (coal, limestone, and various combinations of other minerals). Hot springs with surrounding rock rich in coal (rdo sol) and calcite (chong zhi) are consideredto cure chronic inflammation, "hidden fever" (gab tshad), and orthopedic disorders. Hot springs associated with high levels of coal and sulfur (mu zi) are held to be curative in cold and lymph disorders, but with a tendency to increase wind disorder. Combined disorders of bile and phlegm can be cured by hot spring water that is rich in coal and mineral pitch (brag zhun). This is considered especially good for bile and inflammation-related disorders of the digestive system. Hot spring waters dominated by coal, calcite, and sulfur have a neutral or balancing quality and cure all chronic diseases, especially those of a cold and phlegm-damp nature (badkan grang ba), such as various kinds of rheumatism and arthritis.

Cold lymph disorders (chu ser grang ba) and chronic inflammation (rnving tshad and grams tshad) caused by a combination of the three humors- wind, bile, and phlegm- are positively affected by bathing in hot springs where the area is rich in coal, sulfur, mineral pitch, and red arsenic (!dong ros). Hot spring waters are generally indicated for chronic hidden fever, chronic fever (rnving tshad), chronic rheumatism ('grum bu'i nad), arthrosis and arthritis (tshigs grum), skin problems, "cold kidney" disorder (mkha/ grang), joint pains, nerves, and chronic wind disorders, neurological and muscular diseases (rtsa dkar chu rgvus ned), paralysis (rtsa grib nad), dry skin, stress, and burnout syndromes. For these conditions regular bathing in hot spring waters is held to provide curative and therapeutic effects. To determine the duration of the use of hot springs (including the ideal hours of the day for bathing) and of complementary practices requires the advice of a Tibetan medical doctor. Usually several weeks of such therapies are needed to bring beneficial results. Patients also receive oil massage, oil therapy, moxibustion, and horme therapy (see below), and are given nutritional advice by their doctors.

Medicated baths are prepared with a decoction of herbs, which is added to warm bath water with a small amount of chang (barley beer) The most popular and a widely praised medicated bath in Tibetan medicine is referred to by the poetic name "five nectars bath" (bdud rtsi lnga lums). The decoction used has five main herbal ingredients, or "nectars": "human nectar," referring to the dried leaves of a type of rhododendron (ba !u); "deva's nectar,'' from the leaves of juniper (shug pa); "tsen spirit nectar,'' found in the trunks and leaves of mtshe /dum; "naga spirit nectar" from dried leaves of hom bu; and finally, "nectar of the eight classic spirits," which hen pa). General benefits considered to result from medicated baths are an evacuation of excess of body heat and accumulated "yellow fluid" (chu ser) through the body's pores. Medicated baths control and calm wind disorders, reduce swellings, and increase body weight, especially in cases when weight loss occurred due to aggravated wind.

Chief among Tibetan medical massage therapies are kunye andjugpa. Kunye massage (bsku mnye) is a practical and effective method to restore energy in the body and keep the three nyepa in balance. The term derives from ku (bsku, anointing [the body]) and nye (mnye, rubbing, massaging). In kunye, the body is massaged w ith (oily) substances, such as butter. It is based on the Last Tantra texts on oil massage (snum byug) andjugpa application, in which oil massage is especia lly effective method for wind or mind-originated disorders. Gradually, kunye emerged as an independent and supplementary therapy to alleviate many modern complaints and conditions, such as those resulting from stress and tension. Oil application and massage are powerful therapies for controlling wind and to aid relaxation. They can also be used for dry skin, muscle shrinkage, insomnia, arthrosis, conditions related to menopause, and other problems. Four types of oil are used in the practice of kunye: from seeds such as sesame or mustard; clarified butter, or ghee (zhun mar); from bone marrow; and from fats of various animals. Other medicinal ingredients can be added, or readymade essential oils used, according to the need of the patient. A wind disorder, for example, indicates the use of oils enriched with essences of pine, juniper, artemisia, nutmeg, or other essential oils of warming nature.

Bile-related ailments demand oils fortified by essences from eucalyptus or sandalwood, or other cooling essences combined with those of camphor (ga bur). For phlegm imbalances, essences with drying and warming qualities, such as ginger (Aipina galanga, dong gra), or cinnamon are used. Jugpa (byugs pa), another form of application, requires richer and thicker oils and fats on the body . The Four Tantras states that application of jugpa prolongs one's lifespan, increases the digestive fire, or medro, and improves memory. Once jugpa substances are applied, the points of application are rubbed with roasted barley flour, or tsampa (rtsam pa), which absorbs the oil. As in kunye, special oils are prepared according to specific complaints and conditions. Skin disorders that cause itchiness require equine fat. For loss of kidney heat or semen or for white discharges, oils produced by the otter or marmot are used. Removal of facial acne, as well as treatment of its scars and scars in general, calls for the root of 'bri mag, soaked in goat's fat. "White cataract," a Tibetan subcategory of cataracts understood to result from wind disorder, can be treated with warm massages in the center of the feet, using clarified butter that has been medicated with cumin or caraway seeds.

Massages with clarified butter are used to increase awareness. Applications of mustard seed or sesame seed oils are used for wind disorders, insomnia, dry skin, an unstable mind, a thinly built body, or one that is affected by a wind disorder or constipation, and when one has a desire to gain weight. Bone marrow fat during jugpa application is used for menopausal hot flashes, problems after childbirth (such as failure to deliver, or incomplete delivery of, the placenta), bodies weakened by hard work, loss of energy, and loss of speech or vertigo caused by blocked wind channels (rlung rtsa). Animal fats are also considered to have a significant curative effect when applied to burns, wounds, and painful joints, or in uterine diseases.

The Last Tantra classifies moxibustion and bloodletting as "rough therapies," along with "surgery puncture," or ugpa (dbugs pa), which have been in use for centuries in Tibetan areas, the high Himalayas, and Mongolia. In China, Korea, and Japan, different traditions of moxibustion flourished, and the English term "moxibustion" derives from the Japanese word for the mugwort plant, mokusa. English speakers in the seventeenth century most likely spelled this phonetically as moxa The Dunhuang manuscript, the first historical record of moxibustion in the Tibetan language, was found among thousands of manuscripts in Chinese, Tibetan, and other Central Asian languages in caves in Dun huang, a stop on the Silk Road in the desert of western China. Tibetan moxibustion is used on points on the body called mesang (me gsang, fire points) or simply sang (gsang, point) . These are points on channels through which the body breathes the humors, connects organs, and carries diseases This system is not the same as the Chinese medical concept of meridians, where channels are pathways for qi, In contrast, literal simple description of the points, as given in the Four Tantras and Desi Sangye Gyatso's medical texts, is that these sang and mesang are like holes in a bamboo basket signifying the body. Thus practitioners of Tibetan medicine perceive the body to have many natural holes, or windows, which are connected to channels and the bodily organs. Some moxa points are natural points of organs, or rang sang (rang gsang), for instance the upper chest point (drang gzhung dkar nag gsang). Others, meanwhile, are referred to as nyepa points (nyes pa'igsang), and include the points on the first three vertebrae (according to Tibetan anatomy), which correspond to a seat or outlet of each of the three nyepa of lung, tripa, and beken.

The principal material needed for the practice of moxibustion is moxa wool, or trawa (spra ba). This is generally produced from the leaves of the mugwort plant (Artemisia vulgaris and other Artemisia species) and thin, handmade Tibetan or Nepalese paper. Owing to the mugwort plant's wide availability in Tibet and simplicity of preparation and despite the historically small numbers of trained amchi, the use of moxibustion was extensive. Many men, would carry a small box containing moxa wool with them at all times, ready for use in the home or while traveling, on animals as well as humans. There are many different types of mugwort and they can be found in all parts of Tibet. Mugwort is also commonly used in Tibet as an ingested medicine for colds, in medicinal baths, and in incense. Furthermore, it is commonly burned and used to purify the environment in Buddhist rituals relating to people, animals, and houses. The texts and oral traditions hold that the mugwort leaves intended for moxa should be collected in the three autumn months of the Tibetan calendar, equivalent to the Western months of September, October, and November. For safe and effective use, moxa requires careful preparation. Moxa made by hand is considered more effective than commercially produced moxa cones or moxa sticks.

To prepare moxa, the fluffy leaves of a mugwort plant are collected and dried, then crushed and separated from any branches inside a cotton bag. Once the coarse bits are removed, the leaves are softened by the use of a brush or broom. Now ready for use, the wool can be stored for many years. Just before application, handmade Tibetan paper is cut into two-square-inch pieces. A small amount of moxa wool is placed in the center of the paper. The wool is then rolled up inside the paper. This object should then be even more tightly rolled in the palms of the hands to make it hard. This stage leads it to become shaped like a tiny young carrot, which can then be cut in the middle to produce two cones. Differently shaped and sized moxa are required according to anatomical factors as well as the nature of the disease. For example, moxa placed on the vertebrae should be the size of a fingertip, while moxa for the head, arms, and front of the body should be slightly smaller, the size of a little fingertip. Moxa to "close the channels," meanwhile, should be flat and the size of a bean. Moxa cones for "cold" tumors ('bras) and lumps and swellings (skren) should be thumb-size. On children only tiny moxa cones should be used. Moxa placed on children to treat /hen sna (xiphoid process or upper part of the stomach) should have the proportions of a tiny bean. the advantage of handmade moxa, is that given that the size and shape can be adjusted for different patients and treatments.

There are four kinds of moxa applications, and they differ in the strength of the heat they emit. The Four Tantras describes them as follows:

cooking moxa (btso ba). a method whereby the points are continuously heated up to twenty times (used to treat tumors and swellings);

burning moxa (sreg pa), the direct and repeated application of moxa that burns the skin (used for phlegm disorders such as lymph disorders or cold edemas as well as for "wind in the heart" symptoms, including panic attacks and phobias);

heating moxa (bsro ba) the application of direct and indirect heat to the skin, which should be repeated five or seven times);

and finally, warming moxa (sdtg pa). which acts only to warm the skin and is used mainly in children.

Moxa should not be placed directly on the skin. Traditionally, a small amount of garlic or onion juice is first put on the selected points. The tip of the cone is set alight and while the moxa burns toward the skin of the patient, it is blown upon from time to time , in nomadic areas of Tibet, moxa cones are often burned all the way down to the skin, leaving blisters. Such burned moxa points heal by themselves and do not leave a scar; however, strongly burned moxa, either intentional or accidental, can leave permanent marks on the skin. Many Tibetan and Himalayan patients actually ask for this kind of moxa application, as it is seen as more effective than only lightly warming moxa. After the therapy is completed, it is usual to apply a little butter mixed with salt to the point; . Moxibustion is indicated for general phlegm disorders, such as indigestion, chronic indigestion (bad kan /hen), and metabolic disorders, gastritis, reflux, hypothermia, vertigo, joint pains, mild arthritis, arthrosis, bone deformation, mild rheumatic pains, "empty fever," post-menopausal conditions (such as rlung tshabs), pains caused by stress and tension, insomnia, "wind in the heart" symptoms, "wind-fever" (rlung tshad), and mental and neurological disorders There are contra indications to moxa therapy. It must not be used for acute fevers, hot bile and blood disorders (infections, for example), high blood pressure, gout, and general infections, cancers, and serious skin disorders. It should also be avoided on the sensory organs and the genitals. moxibustion should not be applied during snowfall, heavy rains, as well on days of a full or new moon, and when there is a lunar or solar eclipse, during certain days of the month, on certain locations of the body, in accordance with the locations of the circulating Ia, or vital energy, within certain parts of the body (the so-called bla gnas).

La is one of several important Tibetan concepts of a vital force or vital energy, which moves every day to a different place. At the new moon, Ia is in the first joint of the right big toe in women and the left big toe in men. On the second day of the lunar month it moves upward, so that by the time of the full moon, it is residing in the head, before progressing back down the other side of the body. In Tibetan medicine bloodletting, or tarka (gtar ka, which literally means drawing blood), is seen as the twin therapy of moxibustion. Bloodletting and moxibustion share several points of treatment . Bloodletting is similarly popular in Tibet, both in clinical and home settings and in urban and rural areas. Farm animals are also commonly treated by bloodletting, especially during the spring season in order to clean their blood and help them grow strong new fur. From a Tibetan medical viewpoint, blood is connected with the vital and hollow organs and circulates throughout the body with the humors and along other kinds of channels (for example the blood and nerve channels). It then returns back to the heart and other organs. Blood is seen as the carrier of the bile humor in particular and as the "house of fever," infections, and inflammations .

Bloodletting is a technique used to clean impure venous (ngan khrag) blood by releasing toxic gases that are circulating in the body, especially the so-called fire air toxin (me rlung) or what we might refer to today as carbon dioxide. According to the Last Tantra: "releasing blood steam by bloodletting has a better effect than taking more blood." . Bloodletting is classified as a therapy related to tripa, or bile and advised for the treatment of disorders such as inflammation, "disturbed fever" (caused by heavy work or wrong diet), infectious fevers, swellings, wounds, gout, surva disease, erysipelas, "yellow fluid" (chu ser), and leprosy. It is the therapeutic technique of choice in treating diseases manifesting from fevers and/ or blood and bile disorders. There are several instances, however, where bloodletting should not be used: evil spirit possession causing mental disturbances, physical weakness during pregnancy and the post-partum period, anemia, chronic abdominal diseases, and poor digestive fire, that is, any disease manifesting from wind and phlegm disorders.

The last set of external therapies within the Four Tantras are those considered drastic, or invasive, given that they may penetrate or burn the skin including tsug (tshugs) therapies and telpa (tel pa), or cauterization. Tsug literally means to "put on" or "a pply on the point" and refers generall y to the application of heated objects, such as stones, smooth pieces of wood, animal horns, or gzi stones onto specific points of the body. This therapy relieves localized pains and reduces inflammations. Tibetan doctors think that Tibetans have long used stone or wood tsug therapies to cure many disorders. Tsug is discussed in the Four Tantras, together with various kinds of cauterization, the second main type of invasive therapies. Cauterization, or telpa (telpa), is considered stronger than moxibustion because a more powerful form of heating is used, namely the direct application of a heated ca uteri zation instrument (also called telpa) to the affected area (s), thus burning the skin. This therapy, as well as strong and repeated moxibustion, is more effective than milder equivalent therapies for physically hard-working people and people living in cold countries and at high altitude. Like moxibustion, cauterization is also employed in the treatment of animal fractures.

There are various cauterization instruments in use such as a wooden handle, and the type of metal - silver, gold, copper, or special iron . spea king telpa should be ten fingers' breadth long and eight to nine millimeters wide, with an angled head; A telpa usually requires a "seat," or telden (tel gdan). A telden is the same length as the telpa and also features a wooden handle, but it has a flat head w ith one, two, or three holes to accommodate the w idth of the telpa tip. A telden determines the exact location and holds down the place of application during the procedure. Like surgical instruments, cauterization instruments often have depictions on them of the mouth of a mystic water creature (chu srin kha) or flowers Cauterization is usually carried out on the "crown point," or chitsug (dpyi gtsug), the highest point of the head, but is also used on other points on the "white channels" (rtsa dkar), It is also directly applied on joints and fractured areas, to drain accumulation of liquids such as "yellow liquid" (chu ser).

The four different kinds of telpa are indicated for different conditions. Golden telpa are effective in neurological diseases, vertigo, epilepsy, or brain disorders and also to drive out evil spirits. Silver telpa have the same quality as gold te!pa and are especially indicated for draining pus, lymph fluids, and in necrosis and various kinds of tumors. Copper te!pa are good in treating wounds, tumors, and parasites. Iron telpa are used on areas of the body that grow hair, such as on any part of the head, and in bone fractures and bone deformation (they are considered particularly effective in treating animal bone fractures). Iron telpa are also used on the sternum, which is a point to treat the stomach's so-called /hen disorder.

HORME THERAPY is a gently warming therapy, using small wool- or cotton-cloth bundles that are filled with medicinal substances, soaked in medicated warm oil, and applied on points of the body. The name hor refers to the peoples who lived on the northernmost border of Tibetan areas, such as the Mongols, the ancient Kurds, and Caucasians, and who tended to be nomads and pastoralists. Horme, in Tibetan, means fire or heat. Horme is then a warming therapy of northern regions and most likely was a home remedy. It is not mentioned in the Four Tantras, but for a long time it has been practiced by Tibetan physicians. For the preparation of horme one needs pieces of thin, white cotton fabric of about three square inches in size. These are filled with a small amount of roughly ground zati (nutmeg), mixed with white or black gonvo (go snyod, i.e., cumin and caraway seeds). Some points used in horme are the same as those used in moxibustion, but horme has additional points of application. Horme therapy is a simple but nevertheless highly effective technique to treat all disorders of wind. It uses the combination of heat and externally applied medicinal substances to close certain points or sang (gsang) of the wind channels, and to restore the body's "vital energy" and "lifesustaining wind" (srog rlung). It is used as a substitute therapy for moxibustion, when moxa cannot be used, for example in cases of pregnancy, after surgery, in children, and in aged or physically weak people. Horme may also be indicated for people who are healthy but unable to relax, for example those with sleeping difficulties or in need of bodily and/or mental calm. Horme may be used as a rescue treatment in emergency cases of panic attacks, strong trembling, vertigo or fainting, as well as in cases of depression. It is still used by older members of Tibetan households. Traditionally the practice of horme was taught orally and there is very little mention of it in the medical literature.

Tibetan golden-needle therapy or serkhab choethab (gser khab kyi bcos thabs), is probably a more recent phenomenon than tsug therapies, cauterization, or moxibustion. all Tibetan medical practice of this therapy uses only a single golden needle (much thicker and more robust than Chinese acupuncture needles, ); and there is only one point of its application- at the crown of the head (spyi gtsug). It is therefore possible that Tibetan physicians could have invented golden-needle therapy. serkhab therapy was indeed a Tibetan tradition, belonging to a group of "techniques of puncturing" (dbugs pa) discussed in the Four Tantras's chapter on surgical instruments The golden-needle method is specifically intended to restore the energy of the middle or central psychic channel and to regulate the function of the nerves. Therefore, it is particularly recommended for use in cases of epileptic crisis and in vertigo. It is traditionally held that needles made from pure gold are more powerful in treatment than those made of mixed metals. Their size is usually three fingers' breadth in length and about one millimeter in width. There is, however, no fixed size and shape, so significant differences may be seen in needles used by different Tibetan practitioners of the therapy .Golden-needle therapy in Tibetan traditions is indicated for epilepsy, light stroke, neurological disorders, facial paralysis, vertigo that is caused by low or high blood pressure, and weakening of breathing and/or bodily functions also helpful in the prevention of cataracts, the improvement of weak eyesight, poor memory or concentration, and to counter the effects of early-stage dementia. Prior to its use, the Tibetan golden needle first needs to be cleaned, or sterilized by fire. On the needle's (usually thicker) top part, a small amount of moxa wool contained in Tibetan paper is placed and the needle carefully inserted on the patient's "crown point" .

The moxa wool is then set alight and its heat transferred into the scalp through the golden needle. While the moxa is burning, the practitioner visualizes the Medicine Buddha and recites his mantra up to twenty-one or more times. Once the moxa wool is completely burned, the needle is removed. application should be kept clean and the patient is advised to avoid taking cold drinks or a shower for twenty-four hours. If necessary, the therapy can be repeated after three months, six months, or one year. Contraindications for golden needle therapy are cases of fever, hot bile disorders, infections, bilerelated headaches, and "hidden fevers."

Cupping therapy in Tibetan medicine is most commonly specified as fire-cupping, or mebum (me bum) and also as copper-cupping, or sangbum (zang bum). The cups used are usually made from copper, bronze, or glass, sometimes even bamboo . They are applied in order to collect "yellow fluid" or serum and blood, and in order to remove blockages of wind from muscles and channels. Cupping is a relatively simple and effective technique, which can be undertaken at any time The standard size for cups used in mebum is four fingers' width at the opening and in height, but according to the location of cupping on the patient's body, other shapes and sizes of cups may be used. On the abdomen, chest, and back, however, in general the cups have to have the regular size, while on joints and certain other areas they can be smaller. Cupping instruments have a particular, pear-like shape, but in case a medical cup is not available, one can use any type of cup, such as a teacup or even a glass. Cupping therapy can be employed in the treatment of conditions such as back and shoulder pains caused by stress and tensions, difficult mental work, lower back pain, external lipoma (tshi/ skran), or pains in upper parts of the back. It is also helpful in patients suffering from shortness of breath or aching in the chest, neck, or head associated with tension and/or high blood pressure.

To apply mebum therapy, a small piece of paper is set alight and placed into the cup, which is then turned upside down and applied directly over the painful or affected area. The cup is sucked onto the skin through the force of the vacuum caused by fire. Cups are usually kept in place for fifteen to twenty minutes. After the cup is removed, the area is swollen and colored red or blue. According to the severity of the patient's condition, this area may then be treated further. For instance, in patients with high blood pressure, those with impure blood, headaches, bile prevalence, and/or red spots in the eyes, small incisions are made in the swollen skin area using a lancet or other specialized instruments. Then mebum is repeated as before, and when the cup is removed, dark blood and serum will have been drawn out of the body, which is seen as a successful outcome of the therapy.

HORN SUCTION THERAPY Horn suction therapy, or nabre chothab (rngab ras bcos thabs), has also been in widespread use for a long time among Tibetan medical practitioners and lay people. In contrast to other types of cupping, in this case the cupping instrument is made from an animal horn. Horns of a white yak, or dzo (offspring that result from breeding a yak with a cow). are most practical because they are transparent and the amount of blood collected inside the instrument can be seen from the outside. The horn size is generally five fingers' breadth high and about two or three fingers' breadth wide. Horn suction therapy is used for conditions such as arthritis, rheumatic inflammation, and in joint traumas. It is especially helpful in treating gouty inflammation of small body parts such as thumb, knee, heel, or big toe. In practice, a clean horn is applied with its (soft) opening on the area of the pain, inflammation, or hematoma. In earlier times, horn suction was done by sucking on the tip of the horn (which has a small hole) with one's mouth. The tip of the horn was then closed with a soft chewed tendon, before being beaten with a small stick to make it adhere more strongly to the skin. The horn is applied for about twenty minutes and when it is removed, as with cupping, leaves a swollen area, bluish-red in color. Subsequently, several incisions are made in the skin with a clean lancet and the horn is again applied to the same point. Air is again removed by suction and the horn left in place for approximately twenty minutes. When it is removed, any dark blood that has gathered on the skin should be cleaned off and the wound disinfected and dressed. The condition of "sunken liver," commonly affecting children, is identified in Tibetan medical practice and within Tibetan cultures at large. In essence, the liver has prolapsed or enlarged by inflammation. Affected children develop fever and lose their appetite and in the case of infants show little desire to breast feed. This condition (mchin pa babs pa) is treated by a technique (byis pa'i melong babs bcos) that uses a large mirror, or melong (me long), to restore liver function to normal. It is a simple method used by Tibetan medical practitioners, but used mainly by older women in the home, especially grandmothers or mothers.

Within Tibetan medical minor surgery practice the instruments called thur ma (spoon) were used to drain and remove diseased parts from various organs, as well as from the head, joints, and muscles. The characteristic of Tibetan cataract surgery is that using the "eye spoon," the opaque membrane (i.e., the cataract) is opened horizontally, then rolled and pushed either up or down, so that it no longer obscures the pupil. It is not removed completely. Beside the simplicity and usefulness of this specific technique, it is said that the Tibetan cataract operation is beneficial, as spectacles are no longer needed after the operation. Should a person after surgery, however, continue to carry out hard physical work or possess ongoing strong wind disorders, it is considered possible that the diseased membrane may cover the eye once again, the problem thus recurring. Therefore, following cataract surgery, a patient was advised to pay good attention to his or her physical and mental health as well

In Tibetan, the term tsi, which is usually translated as "astrology," refers in fact to astronomy, time calculation, and divination. These Tibetan astral sciences are further divided into what is usually translated as "elemental astrology," or chungtsi ('byung rtsis), and "astronomy/astrology," or kartsi (skar rtsis). Chungtsi is also known as "Chinese divination," or nagtsi (nag rtsis). This refers to a system of divination based on primary concepts also found in Chinese divination: the relationships formed between the five phases (wood, fire, earth, metal, and water, ) and their various representations, the twelve animal signs (rat, ox, tiger, hare, dragon, snake, horse, sheep, monkey, bird, dog, and pig), the trigrams (spar kha), and numeric squares (sme ba). The corpus of astrological/divinatory sciences is furthermore referred to as tsug/ag (gtsug lag), a term that also refers to the sciences as a whole. The word tsuglag covers a broad range of meanings but most generally refers to treatises (sastra) of techniques, sciences, morality, and the art of governance

Medicine and astrology have been closely interlinked in Tibet, theoretically, practically, and institutionally. Tibetan doctors are required to study some basics of Tibetan astrology as part of their training . Divination has played a significant role in all levels of Tibetan society. Calculations of the relationships formed by the five elements (wood, fire, earth, metal, and water) are frequently applied in all aspects of life, such as birth, marriage, detecting obstacles, analyzing disease, analyzing spiritual progress, and foretelling death. There are various types of auspicious and inauspicious dates, which are marked on every Tibetan calendar. A Tibetan almanac is published each year by the astrology departments of major Tibetan medic medical institutions .

The waxing half of Tibetan lunar months is considered more auspicious than the waning. practices during the first half of the lunar month Astrological divination of illness has occupied a major part of divination practices in general. These practices, assigned to an astrologer rather than a doctor, are considered significant especially in cases where the patient was not seen to respond to medical treatment (The degree to which the life-spirit or lifespan has been dissipated; the degree to which a person is sought after or exploited by malevolent forces; the degree to which the "heavenly life-line" has been cut, and others.). With regard to divination of illness, this illuminated manuscript shows for instance the "pine tree divination" technique, which uses pebbles .

If a negative outcome is reached - marked by black pebbles - rituals are performed to ransom the life-spirit. Diet and modes of dress are also prescribed to counteract the demons responsible for ailments. Divination is also used in medical contexts in order to determine the existence of what is termed spirit-inflicted illness. These are illnesses are attributed to nine types of spirits. It is said that in order to treat such an illness, it is necessary to identify which type of spirit is causing the affliction. Various divination methods for diagnosing such illnesses are described in the medical writings

. Another link between medicine and time calculation is the seasonal influences on pulse diagnosisn It is presupposed that seasons have an effect on the pu lse, and since each season has its particular activity pattern, a doctor needs to know the exact time of the season in order to be able to read the pulse correctly. For example, if the diagnosis takes place in the spring, when the wood element prevails and if at this time both the seasonal wood element pulse (i.e., the liver pulse) and the water element pulse (i.e., the kidney pulse) are flourishing, then the prognosis is excellent. These are based on the mother-son and friend-enemy relationship between the five phases and the patient's organs . A Tibetan doctor is shown as being able to read in the pulse information regarding the patient's family, guests, enemies, finances, relationship with spirits, prospects, and procreative fate. Other themes in which medical and astrological realms interact are the collection of medicinal herbs and the preparation of medicines . The Tibetan term rigne, which is usually translated as "science," also means "art," "culture," or "a field of knowledge."

According to the changes of urine the doctor may identify which type of negative spirit is affecting the patient. Some of the negative spirits, which a physician would try to diagnose in this way, are the /u (klu), nyen (gnyan), thiu rang (the'u rang), and menmo (sman mo). The /u are snake-like water spirits originating from rivers, lakes, and springs who may provoke leprosy and other illnesses if disturbed, the nyen are known to cause illnesses that transmit from person to person; the thiu rang are seen to inflict illness upon children; and the menmo mentally disturb young girls especially.

In the practice of divinatory aspects of pulse diagnosis, particular emphasis is placed on the influence of the seasons on the viscera and their relationship with the five elements Season Element Spring Wood Summer Fire Seasonal junctions Earth Autumn Metal Winter Water Day/Planet (Tib.) Day nyima Sunday zlaba Monday migdmar Tuesday '/agpa Wednesday phurbu Thursday pasangs Friday spenpa Saturday Organs liver and gall bladder heart and small intestine spleen and stomach lungs and large intestine kidneys, reservoir of reproductive fluid, and urinary bladder Planet Symbol sun solar disk moon crescent Mars red eye Mercury hand Jupiter thunderbolt/ dagger Venus arrow Saturn bundle Seasons have an effect on the pulse, and hence a doctor needs to know the exact time of the season in order to be able to read the pulse correctly. As each season also has its particular activity pattern, knowing the exact time of the season is equally important for prescribing fitting behavioral changes or adjustments. The Tibetan year of 360 days is divided into four seasons of seventy-two days each, which are marked by four seasonal junctions that last for eighteen days each. During each of these four seasons and the seasonal junctions, a respective element prevails: wood in spring; fire in summer; iron in autumn; water in winter. During seasonal jUnctions, the element of earth prevails. The seasons and elements are also associated with internal organs.

Each of the lunar months consists of thirty days and is marked by a constellation and associated with an emblematic animal called the master of the month (z/a ba'i bdag po). During each season, characterized by certain events observable in the externa l environment, the organ pu lses, corresponding to the life element of the season, are said to be flourishing (dar ba). For example, during the seventy-two days of the spring season the element of wood prevails Trees blossom and the lark sings. During this period, the pulses of the liver and ga ll bladder (the two organs associated with the wood element), flourish in accordance with these external phenomena. This pulse is described as beating thin and twisted, like the singing of a lark or like the string of a lute. During the first season junction, that is, during the last eighteen days of the third lunar month, the earth element dominates. At this time, the pulses of the spleen and the stomach, which are in correspondence with the earth element, flourish and they beat short and smooth, like the singing of a sparrow.

Sowa Rigpa (Gso ba rig pa), the Tibetan "science" or "wisdom," of healing, was for a long time the main medical resource for Tibetan populations. It has also been practiced in other Himalayan regions, including modern northern India, Nepal, and Bhutan, as well as in what is today Inner Mongolia, the Republic of Mongolia, and Buryatia, where it served a similar function. One of the core texts of Sowa Rigpa found across the Himalayas, in Tibetan areas and beyond, is the Gyushi, or Four Tantras. The Four Tantras is the most important classical Tibetan medical text and teaching manual for Sowa Rigpa practitioners, who are known as amchi, menpa, or drungtsho. The Four Tantras comprises 156 chapters, which are contained in four separate treatises, (278-279)

**Emotionally focused therapy (EFT)**

Evidence-based Emotionally focused therapy (EFT) is an integrating systemic, humanistic, and experiential science therapy for couple distress grounded in attachment theory and social neuroscience, EFT provides practitioners with a clear map for navigating the potential challenges of adult love relationships. According to EFT-C, a couple's dynamic is determined by each partner's emotional experience and how these interact. Conflicts and distress are conceptualized as resulting from rigid and repeated maladaptive interactional cycles that arise when the partners’ basic emotional needs for closeness and validation are not met. When these needs are thwarted, partners experience emotional pain (fear, loneliness, and shame), which drives them to engage in maladaptive behaviors in an attempt to elicit a response from their partner and protect themselves from their emotional pain. often lead to conflict escalation. (281-282)

**Social neuroscience**

Social species, by definition, create emergent organizations beyond the individual—structures ranging from dyads and families to groups and cultures. These emergent social structures evolved hand in hand with neural, hormonal, cellular, and genetic mechanisms to support them because the consequent social behaviors helped these organisms survive, reproduce and, in the case of some social species, care for offspring sufficiently long that they too reproduced thereby ensuring their genetic legacy. Social neuroscience is the interdisciplinary field devoted to the study of these neural, hormonal, cellular, and genetic mechanisms and, relatedly, to the study of the associations and influences between social and biological levels of organization. Our biology has helped shape the social environments we have created, and our social environment has helped shape our genes, brains, and bodies. Social neuroscience can be viewed as a single, overarching paradigm in which to investigate human behavior and biology, and where we as a species fit within the broader biological context.

Social psychology is a science of social behavior, as well, but the emphasis is on how thought, feeling, and behavior of individuals are influenced by the actual, imagined, or implied presence of others. Social perception and social cognition—intrapersonal level psychological processes, and social interaction and influence—interpersonal and group processes, are both vital aspects of social psychological analyses of behavior. Although investigations of the role of biological factors can be found in social psychology , the field has emphasized the role of situational factors and, in collaboration with personality theorists, the role of dispositional factors. Social behavior, social psychology and social neuroscience have the potential to be aligned. This notion dates back at least to the third century B.C.E., when the Greek physician Erasistratos used his observations of peripheral physiological responses, such as the appearance of an irregular heartbeat and pallor in a young man when his stepmother visited. During much of the 20th century in the neurosciences, the individual was treated as the fundamental unit of analysis, and the brain was treated as a solitary information-processing organ. This is an entirely understandable starting point. The brain, the organ of the mind, is housed deep within the cranial vault, where it is protected and isolated from others, as are the neural, hormonal, and genetic processes of interest to most biological scientists. Even cognition, emotion, and behavior can be thought of as beginning with the neurobiological events within individual organisms, events that can be isolated and examined. the study of human behavior by neuroscientists, and many cognitive and behavioral scientists, in the 20th century tended to focus on single organisms, organs, cells, intracellular processes, and genes.

Human social behavior is complex, and many behaviors can be ambiguous as to their origins. One may eat because one is hungry, but often it is a habit to eat at a particular time of day, or a social occasion in which the consumption of food is the norm. The identification of which genes, gene transcripts, proteins, cells, cell assemblies, brain regions, and neural networks are relevant to a given behavior is advanced by the empirical isolation of the underlying psychological component processes. Social psychology is rich in theoretical models that specify conceptual structures and processes underlying a variety of social behaviors, and behavioral paradigms exist that permit the isolation of posited structures and processes for empirical analysis Social neuroscience seeks to specify the neural, hormonal, cellular, and genetic mechanisms underlying social behavior, nd in so doing to understand the reciprocal associations and influences between social and biological levels of organization. To identify the cause of the individual’s malady—lovesickness , the fields of social psychology and social neuroscience become aligned. Developments in multi-modal structural, hemodynamic, and electrophysiological brain imaging acquisition and analysis techniques; more sophisticated specifications and analyses of focal brain lesions; focused experimental manipulations of brain activity using transcranial magnetic stimulation and pharmacological agents; and emerging visualization and quantitative techniques that integrate anatomical and functional connectivity—in addition to information about neural processes at different scales of organization—are creating new opportunities for scientific investigations of the working human brain.

Social isolation decreases the lifespan of social species ranging from *Drosophila*  to Homo sapiens . Humans, born to the longest period of total dependency of any species and dependent on conspecifics to survive and prosper across the lifespan, fare poorly both mentally and physically when they are socially isolated or they perceive they are socially isolated The mechanism suggested initially for the association between social isolation and mortality in humans was that isolated individuals engage in poorer health behaviors evidence is accruing in humans that social isolation, and especially perceived isolation, has deleterious effects on health through its effects on the brain, hypothalamic pituitary adrenocortical axis, vascular processes, blood pressure, gene transcription, inflammatory processes, immunity, and sleep. Hominids have walked the earth for approximately 7 million years, with Homo sapiens having evolved within approximately the last 1% of that period, only the last 5 to 10% of which is characterized by human achievements and civilization Estimates among biologists a decade ago were that 100,000 genes were needed for the cellular processes responsible for human social behavior, but humans have only about a quarter that number of genes

The prefrontal cortex is thought to be particularly important for critical behaviors such as executive function and working memory, yet the ratio of prefrontal to total cortical gray matter is no greater in humans than it is in nonhuman primates. Although humans may have more cortical neurons than other mammals, they have barely more than whales and elephants. The specialized capacities of humans may result from the increased number and processing capacity of synapses in the brain, greater cell-packing density, greater connectivity, and higher neural-conduction velocities, raising the brain’s overall information-processing capacity. Other specialized capacities of humans range from hands with fingers and thumbs to theory of mind and language. Together, these properties support complex and coordinated collective enterprises. our brains have evolved to connect to other minds, and our remarkable accomplishments as a species reflect our collective ability rather than our individual might. Accordingly, there is a growing potential for social neuroscience to inform social cognition, emotion and behavior, as illustrated for instance by the growing literature on oxytocin and trust (e.g., Norman et al., in press) and on brain, genes, and culture.

Social neuroscience , that emerged in the early 1990s as an interdisciplinary field devoted to understanding how biological systems implement social processes and behavior, capitalizing on biological concepts and methods to inform and refine theories of social processes and behavior, and using social and behavioral concepts and data to inform and refine theories of neural organization and function, addresses basic and complex processes that contribute to social behavior and combines the use of neuroscience methods and theories to understand how other people influence our thoughts, feelings, and behavior and uses the brain and body to understand how we think and act, with a focus on how we think about and act toward other people. More specifically, social neuroscience is an interdisciplinary field that uses a range of neuroscience measures to understand how other people influence our thoughts, feelings, and behavior from a multilevel perspective that includes the study of the brain and body.

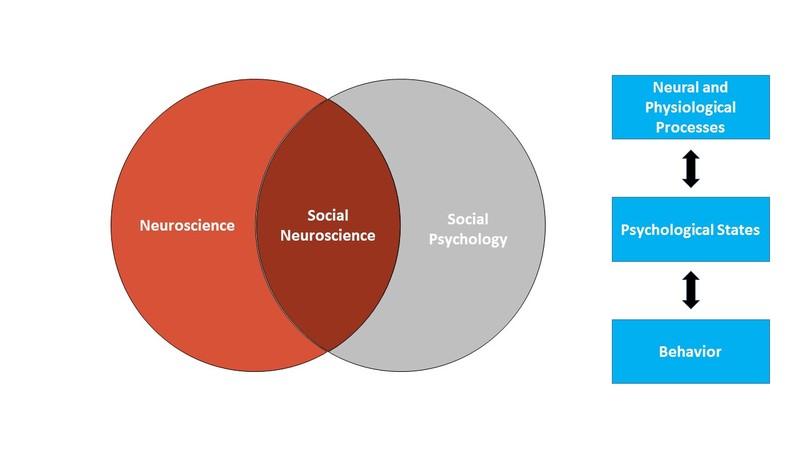


Fig.41. social neuroscience

Social neuroscience is the intersection of social psychology and neuroscience. Under this multilevel approach, neural/physiological processes and behavior are two things we can measure or observe. Psychological states cannot be directly observed, but understanding them is the goal. Social neuroscientists use the observable neural/physiological processes and behavioral responses to make inferences about unobservable psychological states. The bidirectional arrows show that all levels of analysis are assumed to influence each other (e.g., psychological states can influence neural responses, and neural responses can influence psychological states).Social neuroscience can be thought of as both a methodological approach (using measures of the brain and body to study social processes) and a theoretical orientation (seeing the benefits of integrating neuroscience into the study of social psychology). The overall approach in social neuroscience is to understand the psychological processes that underlie our social behavior. Because those psychological processes are intrapsychic phenomena that cannot be directly observed, social neuroscientists rely on a combination of measureable or observable neural and physiological responses as well as actual overt behavior to make inferences about psychological states .

[**Social categorization**](https://nobaproject.com/modules/social-neuroscience#vocabulary-social-categorization) is the act of mentally classifying someone as belonging in a group. Rather than effortfully thinking about every detail of every person we encounter, social categorization allows us to rely on information we already know about the person’s group. The stored group beliefs might not be very accurate, and even when they do accurately describe some group members, they are unlikely to be true for every member you encounter. In addition, many beliefs we associate with groups – called [**stereotypes**](https://nobaproject.com/modules/social-neuroscience#vocabulary-stereotypes) – are negative. This means that relying on social categorization can often lead people to make negative assumptions about others.

An area in the prefrontal cortex called the [medial prefrontal cortex](https://nobaproject.com/modules/social-neuroscience#vocabulary-medial-prefrontal-cortex) (mPFC) – located in the middle of the frontal lobe – is active when people think about themselves. While EEG measures the brain’s electrical activity, fMRI ([functional magnetic resonance imaging](https://nobaproject.com/modules/social-neuroscience#vocabulary-functional-magnetic-resonance-imaging)),measures changes in the oxygenation of blood flowing in the brain. When neurons become more active, blood flow to the area increases to bring more oxygen and glucose to the active cells. fMRI allows us to image these changes in oxygenation by placing people in an fMRI machine or scanner , which consists of large magnets that create strong magnetic fields. The magnets affect the alignment of the oxygen molecules within the blood (i.e., how they are tilted). As the oxygen molecules move in and out of alignment with the magnetic fields, their nuclei produce energy that can be detected with special sensors placed close to the head. Recording fMRI involves having the subject lay on a small bed that is then rolled into the scanner. While fMRI does require subjects to lie still within the small scanner and the large magnets involved are noisy, the scanning itself is safe and painless. Like EEG, the subject can then be asked to think about different topics or engage in different tasks as brain activity is measured. If we know what a person is thinking or doing when fMRI detects a blood flow increase to a particular brain area, we can infer that part of the brain is involved with the thought or action. fMRI is particularly useful for identifying which particular brain areas are active at a given point in time. Human beings are intensely social creatures – our lives are intertwined with other people and our health and well-being depend on others. Social neuroscience helps us to understand the critical function of how we make sense of and interact with other people. (283)

**Attachment theory**

Attachment theory is a lifespan model of human development emphasizing the central role of caregivers (attachment figures) who provide a sense of safety and security and hypothesizes that early caregiver relationships establish social–emotional developmental foundations, but change remains possible across the lifespan due to interpersonal relationships during childhood, adolescence, and adulthood. Attachment can be defined as a deep and enduring emotional bond between two people in which each seeks closeness and feels more secure when in the presence of the attachment figure. The initial and perhaps most crucial emotional bond forms between infants and their primary caregivers. Distinct behaviors characterize attachment in children and adults, seeking closeness with the attachment figure when distressed or threatened

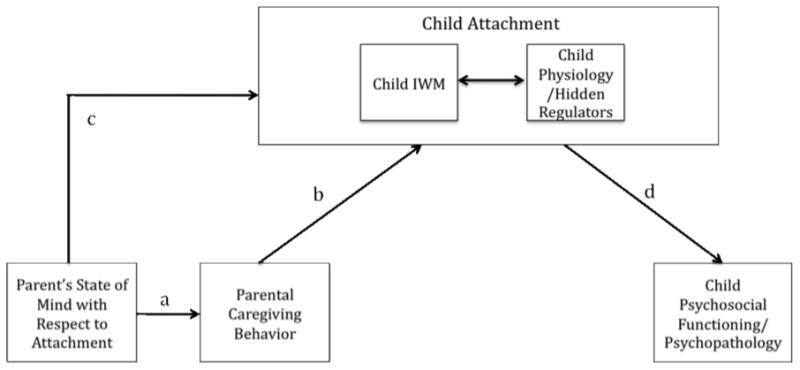


Fig. 42. A complete depiction of attachment processes. The parent’s own attachment representations as a contributor to parental atatchment related behavior. There are many other important contributors to parental behavior , including culture , parental age, parental personality, child temparement, and presence or absense of apartner.

One of the key concepts in attachment theory is the “attachment behavioral system,” which refers to an organized system of behaviors that has a predictable outcome (i.e., proximity) and serves an identifiable biological function (i.e., protection). Attachment researchers have assumed that infants recall the emotional nature of their attachment-related social experiences with specific individuals (e.g., experiences of comfort with vs. rejection by mother), and these memories guide their attachment behavior in subsequent interactions with these individuals.  One useful conceptual perspective, called rational constructivism, is based on the idea that infants use probabilistic reasoning when integrating existing knowledge with new data to test hypotheses about the world.

In humans, a fully developed stress response system, the HPA axis, is present at birth A growing body of research indicates that differences in the quality of early care contribute to variations in the initial calibration and continued regulation of this system. This regulation in turn plays an important role in shaping behavioral responses to threat Just as infants are thought to have evolved a capacity to use experience-based information about the availability of a protective caregiver to calibrate their attachment behavioral system and given the close intertwining of the attachment and fear systems, it is likely that infants also evolved a capacity to use information about the availability of an attachment figure to calibrate their threat response system at both the behavioral and physiological levels . In humans, representations and physiological (e.g., stress) reactions are thought to affect each other in ways unlikely to occur in other species.  The representations that others will be unavailable or rejecting when needed – that is, representations that characterize insecure attachment – could contribute to chronic activation of physiological stress response systems, as could the associated representations of others as having hostile intentions Conversely, in times of both anticipated and actual threat, the capacity to represent a responsive attachment figure can diminish physiological responses associated with threatening or painful experiences

Consideration of linkages between representational and non-representational processes must include the possibility that causality flows in both directions Especially during the early years of life, both of these circumstances are likely to be associated with infant distress. When infants experience comfort from parental sensitive responses to their distress, they develop mental representations that contribute to security (“When I am distressed, I seek care, and I am comforted”). These representations are then thought to guide secure attachment behavior, and the physiological regulation that comes from regaining calmness in contact with the parent is thought to calibrate the child's stress reactivity systems and feed back into further secure mental representations The greater predictive power of the maternal response to distress, compared to maternal response to non-distress, may emerge from the considerable intertwining of infant distress and the infant's attachment system during the first year of life. cognitive processes to understand, justify, or eliminate the stressor. Despite a conceptual model of intergenerational transmission in which maternal behavior is central, examination of additional linking mechanisms purported to underlie maternal behavior, such as maternal cognitions and emotions, will continue to be important.

There is evidence that the components of maternal cognition (e.g., perceptions of the baby, attributions about infant behavior and emotions, maternal mindmindedness) are linked to maternal and/or child attachment. The attachment insecurity in adulthood is concurrently associated with negative health behaviors (e.g., poor diet, tobacco use;  and problematic health conditions (e.g., chronic pain, hypertension, stroke, heart attack;  social/personality psychologists have generated substantial and compelling empirical support for a connection between adult attachment and prosocial motives and behaviors. Adolescence is a period of increased risk-taking behavior and mental health disorders and attempts to reduce these problematic symptoms and behaviors are important. The dramatic biological and cognitive changes that occur during adolescence have led some researchers to consider this period as a second sensitive period and as such, adolescents may be particularly open to environmental interventions that can lead to improved functioning. Attachment research has clearly established the importance of early experiences with parents for child development. Yet far too many parents enter parenthood with insufficient knowledge about child development and the importance of the early parent-child relationship, and without the knowledge and skills needed to parent in a sensitive, responsive manner.

In the context of dramatic social and economic changes, many parents are struggling to strike a balance between work and family responsibilities and to find quality care for their children while the parents are at work or school. According to attachment theory, children are born with a biological system that drives them towards proximity and support-seeking behavior when exposed to distress When parents respond in a sensitive and supportive way to their child’s distress, children develop internal working models of the parent as available for support and themselves as being worthy to be taken care for (called Internal Working Models of the self and others), and children develop a cognitive script about how to elicit care and how care-related interactions from others (called a Secure Base Script;). These children are considered securely attached. When parents are less consistently available for support or when they are unavailable, children develop insecure attachment Internal Working Models and their knowledge of the secure base script is less developed. When distressed, these children show an enhanced focus on their attachment figures and display higher anxiety and stress about possible rejection or absent care by the parent (called ambivalent, preoccupied, or anxious attachment) or they start minimizing the importance of attachment figure and avoiding support seeking (called resistant, dismissing, or avoidant attachment).

Attachment is not only a visible marker linked with the development of psychopathology, it is also a developmental factor about which the main causal factor is assumed to be clear and tangible: parenting behavior. The added value of a clear and tangible causal factor is that this allows designing interventions aimed at stimulating secure attachment development. For these reasons, attachment theory has entered the jargon of every professional caregiver providing (mental) health care, child welfare, pediatric, psychiatric, and educational care. The robust association between insecure attachment and psychopathology resulted in an overly negative appreciation of insecure attachment. It gives the impression that insecure attachment is a symptom of psychopathology.

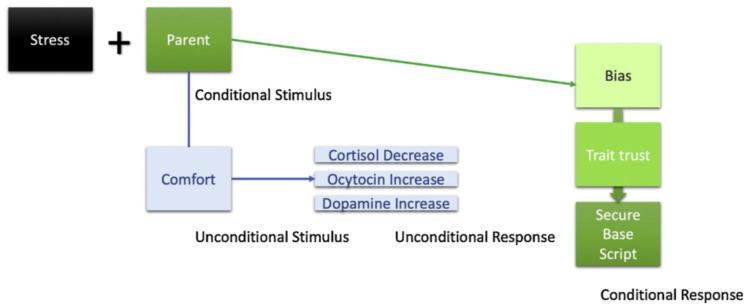
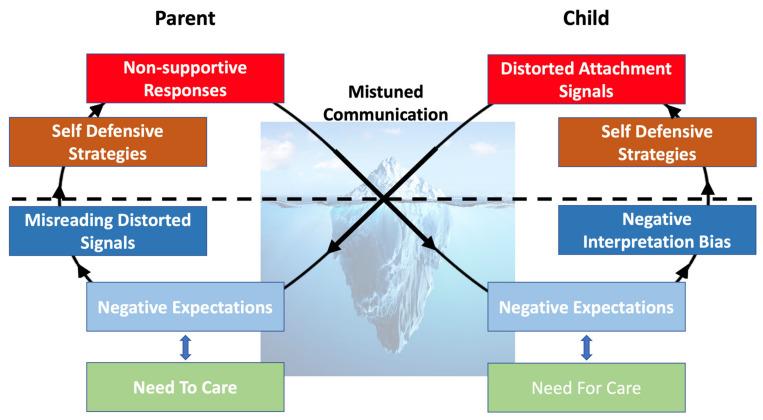


Fig.43. safety conditionning in attachmnet development.

All factors that facilitate or disturb learning processes are supposed to affect children’s attachment development. (284-286)



**Fig. 44. The insecure cycle.**

**Behavioral couples therapy**

Behavioral couples therapy is a broad term for couples therapies that use behavioral techniques based on principles of operant conditioning, such as reinforcement. Behavioral shaping and rehearsal and acceptance are clinical processes found across contemporary behavioral couples therapies. These clinical processes are useful for assessment and case formulation, as well as teaching couples new methods of conflict resolution. Although these clinical processes assist therapists in achieving efficient and effective therapeutic change with distressed couples by rapidly stemming couples’ corrosive affective exchanges, they also address the thoughts, emotions, and issues of trust and intimacy that are important aspects of the human experience in the context of a coupleThe process of behavioral shaping and rehearsal begins with behavioral observation by the clinician. Observing the interactions of the partners plays an important role in assessment, case conceptualization, and determining which interpersonal behaviors will require shaping and rehearsal. Whether using a formal behavioral coding system, such as the Specific Affect Coding System , or more global classes of couple behavior, such as negativity, positivity, and withdrawal, the clinician is looking for behaviors that have been shown to distinguish distressed couples from satisfied couples . Distressed couples have been found to exhibit more negative affect, such as criticism, defensiveness, contempt, stonewalling, and belligerence, in dyadic interactions, and show more rapid and longer-lasting hostility responses Distressed couples also frequently fail at repairing conflict Although satisfied couples also show some negative affect, they exhibit positive affect, such as interest, validation, affection, and surprise or joy, at a ratio of 5:1 to negative affect. Once the clinician has observed the behavioral interactions of the couple and determined the behavior (e.g., target behavior) to be changed, the clinician will begin by modeling desired behaviors for the couple, and then shaping the couples’ displays and providing feedback as they practice the more positive exchanges. This stage of the process allows the therapist to act as an educator, coach, and commentator, and will slow the escalation of conflict, making conflict repairs easier for the couple. Behavior shaping follows from the assumption that couples experience conflict and distress because the couples lack the skills to communicate functionally Behavior shaping has been found to be superior to traditional communication training (e.g., reflective listening; ) because the collaborative nature of behavior shaping produces long-lasting changes in communication patterns Each approach may differ in the exact form of the clinician shaping. (287)

**Enactment ​ therapy**

Enactment ​ therapy, at its core, is a dynamic and experiential approach to mental health treatment. It draws on the principles of psychodrama, role-playing, and embodied cognition to create a transformative experience. Unlike traditional talk therapy, which relies primarily on verbal communication, enactment therapy engages the whole person – body, mind, and spirit – in the healing process.In an enactment, family members are asked to talk. Enactment involves a collapse in the analytic dialogue in which the analyst is drawn into an interaction where he/she unwittingly acts, thereby actualizing unconscious wishes of both himself/herself and the patient. This collapse implies disturbance of the symbolic function. Both earlier symbolized (repressed) material and earlier not-symbolised (trauma-related) material may emerge which is not accessible by language.. Enactment is characterized by a “rupture” in therapeutic dialogue. When there is mutual acting out of coincident unconscious material, particularly traumatic memory, that an enactment, properly defined, occurs. This may occur anywhere along the spectrum from the “gross” such as sexual encounters, to boundary violations such as contact outside the consulting room, to the “subtle” such as physical contact, mutual gestures, and interactions about time and money. The mutual acting out by both therapist and patient of inter-related unconscious material, is enactment as a conceptually and clinically distinct phenomena. Like other primates, humans naturally and unconsciously adopt the posture, gestures, facial expressions, words, and verbal tone of others From an evolutionary perspective this mimicry can be seen as enhancing infantile attachment, pair-bonding, and social cooperation.

Research has demonstrated that this is reflected in brain synchronization, particularly in respect to joint or group motor behavior.The brains of people engaged in a wide variety of tasks, including psychotherapy, literally become attuned to each other, as measured using hyperscanning techniques where two or more subjects' brains are monitored simultaneously using electroencephalographs, magnetic resonance imaging, and near-infrared spectroscopy Subjects also become physiologically attuned as their autonomic nervous systems synchronize as measured by heart rate, breathing patterns, skin conductance, and hormonal and endocrine release Such synchronization plausibly lays a biological foundation not only for coordination of motor tasks, as in couples dancing, but mutual understanding of internal states . In therapeutic contexts synchronization of behavior is associated by patients with greater empathy. How countertransference actually occurs remained somewhat mysterious until the discovery by neuroscientists of mirror neurons in primates. Mirror neurons in humans not only unconsciously trigger in the observer the same pre-motor neurons activated to induce behavior in the observed, but that by mirroring facial expression and gesture they generate understanding of intention and meaning, and induce the same emotions in the observer as experienced by the observed. Like synchronization, this is a “mandatory, nonconscious, and prereflexive mechanism” Mirror neurons are multi-modal, processing verbal as well as visual perception. Action words trigger the same pre-motor mirror neurons as visual observation. A patient or therapist may feel “touched”, physically and emotionally, when the other utters the word.

Therapist and patient internally mimic and therefore experience, “embody” physiologically and emotionally, what the other does and feels, neither being conscious of the process. Their brains and bodies synchronize below the level of awareness. Ideally, in therapy, the corresponding action stimuli are inhibited, thus maintaining an “as if” state in which both can reflect on what is being evoked. These stimuli of parallel bodily and neurological processes imply that the therapist’s feelings, based on both interoception and extroception, while paralleling those of the patient, are not identical as they are of necessity associated with and influenced by the therapist’s own experience. Thus “mirroring” evokes not identical but related feelings and logically triggers recall of similar or related memories, narrative as well as implicit, including traumatic ones.There is a compelling case that mirror neurons are instrumental in the process of creating traumatic memory. Their speed of reaction to multi-sensory inputs and manifold connections with the amygdala where trauma is processed and to a degree stored, as well as with the anterior cingulate gyrus and orbital frontal cortex, suggests as much.

Given evolutionary conservation it is plausible that there are human analogues to the primary emotional circuits identified in mammals including fear, rage, and panic The amygdala is fundamental to fast motor reactions to threat congruent with these emotions including flight, fight, and freezing. One can imagine that in cases of childhood trauma, such as physical or sexual abuse, the mirror neuron system mirrors the intentions and the emotional state of the abuser as well as contributing to the emotional state of the victim. This may be seen to account for the formation of the internal persecutor as well as identification with the abuser. Once the implicit traumatic model is formed the brain is primed to expect renewed episodes and reacts to perceived similar threats by repeating motor responses in the form of acting out and enactment. In therapy, ideally, the error of identifying the therapist as persecutor or victim is recognized and the model can be updated.Acting out by extension enactment, can be seen in neuroscientific terms as the expression of implicit, traumatic memory which is stored in the form of primary motor responses, flight, fight, collapse, and their commensurate feeling states of fear, rage, and panic. The unsymbolized and non-verbal motivations, when stimulated by unconscious synchronization and mirroring, are perceived as immediately threatening, causing it to shift the balance towards the CEN associated with acting and away from the DMN associated with reflection Therapists who “catch themselves” before acting out can be seen to be inhibiting action responses, limiting their reactions to “trial actions” and by doing so can restore their analytic attitude. Neuroscientifically, acting out can be defined as the motor expression of verbally inaccessible traumatic memory by either patient or therapist.

Enactment can be defined as their mutual acting out of coincident unresolved material. The catalysts for the mutual motor expression of these non-declarative memories are unconscious synchronization and mirroring. Enactment materializes when this imbalance occurs in both patient and analyst. Where the analytic attitude is lost, the boundaries between them collapse. Working through what has happened, excepting severe boundary violations, can restore the balance and lead to therapeutic progress.The “talking cure” now depends not only what is said and what words mean, explicitly and implicitly, but on non-verbal communication. The retreat from recall of past events, from neutrality, abstinence, anonymity, and objectivity in favour of mutual, subjective participation in the “here and now” highlights the importance of behavior. This suggests a continuing need for theoretical and clinical descriptions of distinct behavioral phenomena. Enactments are a well-known, nearly universal factor present in psychoanalytically oriented psychotherapy. The ubiquity and tenacity of enactments are generally understood by contemporary psychodynamic theorists to arise from the power of the unconscious to recreate familiar (and thus secure) unconsciously participates in a re-experiencing of the patient’s dysfunctional attachment patterns. While the therapist’s selfawareness and self-reflective process is sometimes sufficient to understand, manage, and utilize countertransference forces unconscious enactments are often difficult to see, curtail.

Enactment therapy typically begins with an initial assessment and goal-setting session. This collaborative approach ensures that the therapy is tailored to the individual’s specific needs and objectives. Creating a safe and supportive environment is crucial in enactment therapy. . This is particularly important given the potentially intense and emotionally charged nature of the environment. The heart of enactment therapy lies in the role-playing and experiential learning that takes place during these scenes. This process can be incredibly powerful, allowing individuals to gain new insights, release pent-up emotions, and practice new behaviors in a safe and controlled enactments.Enactment therapy employs a variety of key techniques to facilitate healing and growth. One of the most powerful technique, the role reversal, to step into the shoes of another person in the life, can be particularly effective in developing empathy and understanding in relationships.

Enactments have traditionally been defined as “an interaction stimulated in structural family therapy in order to observe and then change transactions which make up family structure” A broader definition sustains the potential use of enactments independent of any particular clinical model: Enactments are defined as “therapist behaviors [that] stimulate and guide couple interaction as opposed to channeling interaction through the therapist” .The purpose of the intervention stage of enacted relationships is to give the couple an opportunity to practice communication and interaction skills discussed in the initiation stage, bring the emotional experience of the relationship into the open, work through attachment issues and needs, and resolve problems. During the intervention stage, the therapist is primarily a coach, facilitating and commending positive dialogue and circumventing and redirecting negative exchanges. Through therapist coaching, couples can be led to increasingly self-reliant interaction. When using an enactment, a therapist needs to distinguish between passionate and intense discussion and relationally destructive interaction

A therapist may be tempted to allow destructive interaction to escalate, provided that the couple seems to be working towards the goals of therapy. Adopting such a position prioritizes outcome over process in therapy, something interactional research suggests may ultimately undermine both couple process and outcome When therapists fail to structure enactments with sensitivity to process as well as outcome, the conversation can quickly turn from a productive, therapist-coached dialogue to an escalation of destructive criticism, contempt, negativity, defensiveness and/or hostility, and withdrawal . It is imperative that therapists maintain their professional position in terms of their authority and responsibility to interrupt destructive interaction. Enactments consist of face-to-face couple interaction that is carefully guided by the therapist. Enactments are distinct from role-plays, in which couple interaction is narrowly focused on the development of a specific skill set, or where, as an experiential intervention, couples are invited to assume role positions other than their own. In enactments therapists invite couples into direct interaction with each other, where they are helped to successfully enact their relationship in its real-life totality. The therapist provides coaching in terms of interaction process and emotionally focused probing and invitations, for example to assist the couple in achieving meaningful, secure interaction around attachment and other core issues and strivings.

Couples may thus be enabled to acknowledge and process emotion and make relationship-enhancing changes in their attitudes, attributions, emotions, and attachment .Engage therapy, a cutting-edge approach to mental health treatment, empowers patients to take an active role in their own healing journey, fostering lasting change and personal growth. This innovative method has been making waves in the mental health community, offering a refreshing alternative to traditional therapeutic approaches .At its core, engage therapy is a dynamic, collaborative process that puts the patient in the driver’s seat of their mental health journey to become active participants in their own healing.Active patient participation is the name of the game. Gone are the days of passive listening and nodding. In engage therapy, patients are encouraged to get involved in every aspect of their treatment. It’s like being the star player in your his/her mental health game, rather than just warming the bench. Patient and therapist work together to identify meaningful goals that align with the patient’s values and aspirations. Cognitive restructuring exercises are like mental gymnastics for the brain, helping to identify and challenge unhelpful thought patterns. Improved self-awareness and emotional regulation are also major perks of engage therapy. As patients become more attuned to their thoughts, feelings, and behaviors, they develop a greater capacity to manage their emotions effectively (288-289)

**Dialectical behavior therapy (DBT)**

Dialectical behavior therapy (DBT) is a comprehensive, evidence-based supported treatment for individuals presenting with complex and severe mental health problems, including borderline personality disorder (BPD), depression, suicidal ideation, and and attempts, substance use disorders (SUDs). psychiatric hospitalization. DBT produces long term gains for suicidal BPD patients across a variety of domains and enhances social functioning and global improvements . The patient populations for which DBT has the most empirical support include parasuicidal women with as well as persons who meet criteria for binge-eating disorder, and depressed elderly patients. DBT is a comprehensive program of treatment consisting of individual therapy, group therapy, and a therapist consultation team. In this way, DBT is a program of treatment, rather than a single treatment method conducted by a practitioner in isolation. (290)

**Enmeshment therapy: Breaking free from unhealthy family Dynamics and Reclaiming Personal Identity from Overlapping Family Roles**

Enmeshment is a term used by structural family therapists to describe families with extremely diffuse boundaries where autonomy is compromised. In therapy, clients who have grown up with diffuse boundaries often present complaints about depression, burnout, anger or resentment. “Enmeshment can be defined as the experience of confusion of one’s separateness from others” and a reduced sense of self and autonomy in relationships. It also suggests an inability to “fully experience, understand, and value one’s own thoughts, feelings, and needs in the context of relationship” Enmeshment is often confused with [codependency](https://positivepsychology.com/codependency-definition-signs-worksheets/). While codependency lacks a clear and agreed definition, it typically refers to a dysfunctional pattern of behavior and thinking in relationships where the individual prioritizes the needs of others over their own Codependency is, regarded as an outward manifestation of enmeshment. It focuses on the blurred boundaries and loss of identity within relationships, where individuals rely on one another for their sense of self-worth and emotional wellbeing Enmeshment might be considered at one end of a continuum, with rigid boundaries on the other.

Normal functioning within a relationship occurs somewhere in the middle The concept is considered within a family context, where family members are not differentiated “and become over-dependent on each other, thus blocking individual family members from attaining autonomy” On the other hand, family cohesion is characterized by healthy, transparent, and flexible boundaries that enable each family member to function without interference from others while accessing the resources of the larger family system Enmeshment often arises out of a lack of understanding or awareness of the need to cultivate autonomy during a child’s or young person’s early years. Over time, it can undermine a sense of self, where the individual fails to learn to value their own thoughts and feelings. Enmeshment can result in conditional access to family resources (for example, emotional support) and stress that overspills between family subsystems, immersing individuals in ongoing family issues and hindering personal autonomy As a result of unclear and excessively lax boundaries within a family (or other close relationships), enmeshment can have a significant impact on mental health .

Strong familial ties can be a great source of comfort, emotional support, and cherished memories. However, sometimes these connections become overly involved, leading to blurred boundaries and a loss of individual identity—a dynamic known as enmeshment. In such families, parents may rely on their children for emotional fulfillment, often without realizing that they are hindering their child’s growth into a fully autonomous individual.There are many benefits to having strong bonds with family members. The memories with parents and siblings over a lifetime are irreplaceable, and so is the unconditional love of family. However, enmeshment goes beyond closeness. In an enmeshed family, parents often control their children through emotional manipulation. This control can last well into adulthood. This can happen because parents are so reliant on their children for emotional support that they consciously or subconsciously prevent them from achieving personal growth. An enmeshed family system makes it difficult for children to emotionally separate from their families and become independent people. Families who are too close may be emotionally enmeshed without realizing it. Enmeshment is marked by a lack of boundaries.

Many families have difficulty establishing healthy boundaries, but an enmeshed family’s lack of boundaries is so severe that it can lead to confusion over family roles and expectations.Enmeshment occurs when the lines between family members' emotional and personal boundaries become indistinct. While many families struggle to maintain healthy separations, those dealing with enmeshment often operate in such a way that roles and expectations become muddled. This leads to a dynamic where individuals, especially children, may feel responsible for the emotional well-being of their parents or siblings. Enmeshment can manifest in different ways, but if you feel an overwhelming sense of obligation to your parents or believe you don’t have a right to privacy, you may have grown up in an enmeshed family. Like most dysfunctional family dynamics, enmeshment is typically passed from one generation to the next. Even when they are unhealthy, people tend to create the same type of family they grew up in because it is familiar. Enmeshment is [**thought to originate**](https://psychcentral.com/blog/imperfect/2019/05/the-enmeshed-family-system-what-it-is-and-how-to-break-free#What-causes-enmeshment?) when a child has a serious illness, including mental illness and addiction. It can also happen when a child survives a life-threatening [**trauma**](https://apn.com/programs/trauma-therapy/). In these frightening situations, it is natural for parents to become overprotective. While overprotective behaviors are understandable in some cases, they can become a habit that continues long after they are no longer needed.

**Common indicators of enmeshed relationships include:**

If you grew up in an enmeshed family, these common signs of enmeshment will be familiar to you.

* There is a lack of emotional and physical boundaries.
* You don’t think about what is best for you or what you want; it’s always about pleasing or taking care of others. You feel responsible for other people’s happiness and wellbeing. You feel like you have to meet your parents expectations, perhaps giving up your own goals because they don’t approve. You try to avoid conflicts and don’t know how to say no. You absorb other peoples feelings feel like you need to fix other peoples problems. You don’t have a strong sense of who you are. You always put the needs of others before your own. If you try to assert any independence, your parents make you feel guilty or ashamed. You don’t have secrets from your parents.You’re guilted or shamed if you want less contact (don’t talk to your mother every week or want to spend a holiday without your parents) or you make a choice that is good for you (such as move across the country for a great job opportunity).
* Your parents measure their self-worth to hinge on the successes or accomplishments of their children. Your parents want to know every detail of your life, including ones that should be privateYour parents live center around yours.Your parents don’t encourage you to follow your dreams and may impose their ideas about what you should be doing.Your parents treat you more like a friend than a child and look to you for emotional supportYour parents share inappropriate information with you and/or your siblings.
* Family members overshare personal experiences and feelings in a way that creates unrealistic expectations, unhealthy dependence, confused roles. Often, enmeshed parents treat their children as friends, rely on them for emotional support, and share inappropriate personal information.
* Abandoning personal goals if they conflict with parental expectations
* Basing self-worth on the achievements of children
* Prioritizing others' needs over personal needs
* Feeling shame or guilt when attempting to establish independence
* Lack of privacy or secrecy within the family
* Parental dependence on children for emotional support
* Oversharing personal matters with children
* Excessive interest in and control over every aspect of children’s lives

Such dynamics can lead individuals to internalize a sense of obligation, guilt, and a loss of autonomy. This often begins in childhood and, if unaddressed, can influence behavior and relationships well into adulthood.

**Roots and Intergenerational Patterns**

Dysfunctional family behaviors often stem from earlier experiences and tend to be passed down through generations. Enmeshment may be triggered by traumatic events such as serious illness, addiction, or life-threatening incidents that cause parents to become overprotective. While the protective instinct is natural, it can evolve into a long-term habit that impedes a child’s ability to differentiate and thrive independently.Enmeshment is a dysfunctional family dynamic that is passed through the generations. Enmeshment usually originates due to some sort of trauma or illness (addiction, mental illness, a seriously ill child who is overprotected). However, because its usually a generational pattern, you may not be able to pinpoint the origins of enmeshment in your family.It’s more important to identify ways that enmeshment is causing difficulties for you and work to change those dynamics in your relationships.Older generations often pass down dysfunctional habits from one generation to the next. It may not be possible to pinpoint why your family has become enmeshed, only that they are. Most parents spend any amount of time, money, and energy to strengthen family connections and build a deep sense of belonging among family members. These strong bonds build a support system that allows grown children to go out into the world and pursue their individual goals. In an enmeshed family, children are expected to meet their parents’ goals, not their own. In a close family, members offer emotional support when needed, but they also give one another space. No one is expected to meet another family member’s emotional needs as they are in an enmeshed system.In families affected by enmeshment, children are often molded to serve the emotional or practical needs of parents. This may manifest in responsibilities that surpass age-appropriate expectations, such as becoming caregivers or emotional confidants. These children might find themselves sacrificing academic, social, or personal development opportunities.

**The Psychological and Social Impact**

The absence of emotional boundaries in enmeshed families significantly affects mental health and identity development. Adult children may:

* Struggle with forming independent relationships
* Experience guilt when prioritizing themselves
* Battle low self-esteem due to constant self-sacrifice
* Avoid taking risks for fear of failure or disappointing their family

Without proper boundaries, personal identity is often overshadowed by familial roles. Individuals may mistake their family's values or ambitions for their own, leaving little room for personal discovery.Enmeshment is also closely linked with co-dependency, where individuals derive self-worth from caretaking or fulfilling others' emotional needs. This pattern can repeat in romantic or social relationships, leading to further challenges in establishing healthy, reciprocal connections. Co-dependency and enmeshment have been used interchangeably in psychological and psychotherapeutic practice.

**Steps Toward Healing and Independence**

Overcoming the effects of enmeshment involves deliberate steps to establish autonomy and redefine personal boundaries. Therapy can be instrumental in this process, particularly cognitive-behavioral therapy (CBT) and dialectical behavior therapy (DBT), which help individuals recognize and reshape harmful patterns.

**If family members are open to it, group or family therapy may provide a platform to:**

* Learn respectful communication techniques
* Set and honor healthy emotional boundaries
* Foster mutual independence while maintaining connection

Even if family participation isn’t possible, individual therapy can empower to build self-awareness and prioritize your own needs.

**Practical Tips for Breaking the Cycle of Enmeshment**

There are many things you can do today to end the dysfunctional cycle of enmeshment. Start by learning how to set and protect personal boundaries. Think about the times you have felt guilty, resentful, or unappreciated by your family. These are likely times when boundaries have been violated.

Consider this scenario as a boundary violation example: “I got angry when my mother asked me to help her in the garden because she knew I had planned to study all day for my real estate license test. She began to complain about her back pain when I said I was busy. I felt guilty, so I went to help her instead of studying.”A person with a clear boundary might have told their mother, “No, I can’t garden. Remember, I told you I was studying today?” Or they might have struck a compromise such as, “I need time to study. I can help for two hours if you take the kids tonight so I can get my work done.”Both are examples of protecting your needs and not allowing someone else’s dysfunction to sabotage your success.

with each other rather than to the therapist. This

serves the dual purpose of allowing the therapist

to see ﬁrsthand how clients interact, instead of

relying on their descriptions, and having clients

experience different ways of interacting (Nichols

and Fellenberg 2000).

Theoretical Framework

Enactments are an essential component of Struc-

tural Family Therapy (Minuchin 1974; Minuchin

and Fishman 1981). They are used to explore and

change interactional and organizational problems

in families: how couples talk to each other, how

parents relate to their children, and how relation-

ship triangles inﬂuence family dramas. By bring-

ing the actual dynamics of those relationships to

life in the consulting room, enactments lend

immediacy and authenticity to family therapy.

Although enactments are also used in other

therapeutic modalities, there is an important dis-

tinction. Outside of structural family therapy, the

use is generally more directive, with therapists

interrupting to coach communication skills, often

after almost every client utterance (e.g., Butler and

Gardner 2003; Davis and Butler 2004). The famil-

iar tactic of having couples take turns talking and

listening is an example of this approach, as is the

rehearsal in behavioral marital therapy (Jacobson

and Margolin 1979), the directed dialogues in

emotionally focused couples therapy (Greenberg

and Johnson 1988), and the role-playing and

problem-solving practice in couple enrichment

programs (L’Abate and Weinstein 1987). By con-

trast, enactments in Structural Family Therapy are

relatively unstructured. The therapist acts as a

facilitator rather than a coach. Although he or she

may need to be active in setting an enactment up,

once underway the therapist intervenes only when

necessary to keep it going. Forced to rely on their

own devices, some clients will ﬁnd a way to get

through to each other; others may continue to

communicate in ways that are counterproductive.

When this happens, the therapist points at what the

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through to each other; others may continue to

communicate in ways that are counterproductive.

When this happens, the therapist points at what the

clients are doing that keeps them stucHistorically a clear distinction between speech (talking) and behavior (acting), both symptomatic and occasional, was fundamental to psychotherapeutic theory and practice. The perceived efficacy of obtaining relief from psychic distress by the recovery and verbalization of unconscious or forgotten (repressed) material based on real, traumatic, often sexualized, events and its integration into an explicit personal narrative, was the foundation of psychoanalysis As Freud moved away from what became known as the “seduction theory,” the focus shifted from real events and memory to intra-psychic activity and phantasy, and concern with behavior wanedEnactment, like acting out, was originally seen both as a behavioral breach of therapeutic norms and an obstruction to therapeutic progress. This is particularly vivid in severe mutual boundary violations such as sexual encounters between therapist and patient. to encompass all non-verbal communication including transference, countertransference, projective identification, and introjection, enactment focuses on the mutual substitution of action for words in the expression of unconscious material.

Other tips for ending enmeshment include:

* Engage in activities that increase your self-esteem
* Cultivate your own interests by going to the church you like, studying the subject you’re passionate about, and spending time with the friends you have chosen
* Avoid making decisions based on guilt
* Make an effort to do things without your family
* Make a list of your strengths and remind yourself about them as often as needed
* Seek counseling to help change negative thinking patterns
* Spend time with people you admire, and think about the traits that draw you to them
* Try new things even if you think you might fail
* Encourage independence in your own children
* Create an identity that is separate from your children
* Learn how to say “no” without excuses or apologies
* Practice setting and maintaining personal boundaries, especially in emotionally charged situations
* Identify moments when you feel guilt or resentment—these may signal a need to protect your needs
* Engage in self-esteem building activities and pursue personal interests
* Make decisions based on your values, not guilt or obligation
* Create time for yourself outside of your family dynamic
* Work with a therapist to develop a stronger sense of self
* Say "no" without apologizing
* Encourage independence and personal identity in your own children

Breaking free from enmeshment isn’t fast or easy. It may take a lot of time to learn new, healthy habits. Becoming healthy in a family of people with dysfunctional habits is certain to cause friction. Be prepared for pushback from parents and siblings as you begin to set boundaries and assert your independence. Taking actions that support your mental health helps your entire family in the long run. Enmeshment describes family relationships that lack boundaries, such as those in which roles and expectations are confused. Learning how to set boundaries, developing a sense of self, and seeking professional support may help.

**Final Thoughts: Prioritizing Your Well-Being**

Healing from enmeshment is a gradual but deeply rewarding journey. Establishing healthy boundaries may initially create tension within the family, but over time, it can foster healthier relationships and a greater sense of self. Prioritizing your mental and emotional well-being benefits not only you but can also inspire healthier dynamics within your family.While the roots of enmeshment may lie in generations past, you have the ability to shift the pattern and reclaim your individuality. Support from mental health professionals, trusted friends, and your own growing self-awareness can guide you toward a more balanced, fulfilling life. Most families have expectations for children to do chores and take some responsibility for the running of the household. This not only teaches kids important life skills but also helps them build self-esteem. Children who contribute to the mutual chores feel a sense of pride and satisfaction.

When a family is enmeshed, the children are expected to provide all the cooking and cleaning for the family. Chores and other responsibilities cut into study time or time with friends. Serving the family is viewed not just as a priority but as the child’s absolute obligation.Close families can be very involved in one another’s lives while still maintaining healthy boundaries. The members of an enmeshed family don’t have boundaries. Children aren’t allowed to say no to their parents or create an identity outside of the family unit, and parents depend heavily on their children for their own sense of success. Being raised in an enmeshed family system isn’t easy for children, but the effects of the dysfunction don’t stop in childhood. The impact of enmeshment can be seen throughout an adult’s life if they don’t take the steps to heal. When family members are connected in unhealthy ways, it is difficult to form healthy relationships with other people.

New friends or potential life partners get pushed aside when the needs of parents or others in the family need attention. An enmeshed parent can also put pressure on relationships when they don’t approve of a person. They may influence their grown child to stop seeing the other person or make things so difficult the relationship breaks under scrutiny.Enmeshed family members can be so connected that members blame themselves for any unhappiness or failure of another member. For example, in a healthy family, when an adult child moves far away, members might feel sad and miss the person but also happy that their loved one is pursuing their dreams. In an enmeshed family, even the thought of moving can fill a person with shame. Adult children blame themselves for any unhappiness their parents or siblings might experience. This level of self-blame extends beyond just family. Feeling guilty anytime anything goes wrong at work or in social circles is typical among those who’ve grown up in an enmeshed system.

When there are no boundaries in a family, it’s easy to mistake a parent’s goals for your own. Adult children from enmeshed families might be pressured into pursuing careers, relationships, or activities that their parents want, or they may pursue those goals without ever questioning the source.Trying new things and overcoming challenges is part of how humans build self-esteem. People from an enmeshed family are typically discouraged from trying new things. Failure isn’t seen as a learning experience but as something to be completely avoided. Enmeshed parents may be trying to protect their children from being hurt or they might be protecting their own self-worth by not having a child that failed. Either way, low self-esteem can lead to serious mental health concerns like depression and anxiety.Without support, people from enmeshed families are likely to repeat the same patterns they grew up with. They may choose partners who don’t respect boundaries or partners who use guilt and manipulation to get their way.Being placed in the caretaker role is familiar for those raised in enmeshment. They may struggle with co-dependence issues or enable partners with [**substance use disorders**](https://apn.com/programs/addiction-treatment/).Breaking free from dysfunctional patterns may require the help of a mental health professional. Targeted therapies like cognitive-behavioral therapy and dialectical behavior therapy can help you identify unhelpful behaviors and learn how to replace them with behaviors that build your self-esteem and support your independence.

Many parents don’t realize they are doing anything “wrong” or potentially harmful to themselves and their children. They are simply replaying the same types of family dynamics they grew up in. Boundaries establish appropriate roles who is responsible for what in a family. And create physical and emotional space and safety between family members. They reflect respect for everyones needs and feelings, they communicate clear expectations, and they establish what is okay to do and what is not.As a child grows up, boundaries should gradually shift to allow for more autonomy, greater privacy, developing his/her own beliefs and values, and so forth.In healthy families, children are encouraged to become emotionally independent to separate, pursue their goals, and become themselves not to become extensions of their parents (sharing their feelings, beliefs, values) or to take care of their parents.Enmeshment and Undeveloped-Self in the domain of Impaired Autonomy and Performance, entails excessive emotional involvement and closeness with one or more significant others, often a parent, sibling, or a partner Enmeshed individuals feel indispensable to one another, and personal boundaries seem unreasonable The Undeveloped-Self part of the schema refers to the lack of individual identity and it is often experienced as “emptiness, lack of direction, or even questioning one's existence” The consequences of Enmeshment and Undeveloped-Self range from difficulties in differentiation and separation, increased internalizing and externalizing problems, to difficulties in social and occupational functioning, maladaptive relationship behaviors (e.g., possessiveness, jealousy, coercive control) and increased depression and anxiety In enmeshed families, healthy boundaries don’t exist. Parents overshare personal information. They don’t respect privacy. They rely on their child for emotional support or friendship. They don’t allow children to make their own decisions and mistakes. Children aren’t encouraged to explore their own identities, become emotionally mature and separate from their parents.

This burdens children with:

* the responsibility of taking care of their parents (often when they aren’t emotionally mature enough to do so)
* role confusion (children are expected to take care of their parents and/or are treated as friends or confidants)
* prioritizing their parents needs above their own
* a lack of respect for their feelings, needs, and individuality

**Children need to individuate from their parents** and become independent from their parents in order to become a mature and emotionally healthy adult. Individuation is the process of separating the self physically, emotionally, intellectually, spiritually, and so forth and becoming an individual, not just an extension of the parents.

Adolescence is the time when

the children start spending more time with friends

experiment with their own style and appearance

recognize that they don’t have to believe the same things their parents believe.

gain clarity about their values, beliefs, and interests and are able to express them and act on them.

make more decisions for themselves.

start to figure out whom they are as unique individuals

look to the outside world for greater opportunities.

In enmeshed families, individuation is limited and likely to get stuck in an emotionally dependent, child-like state. This creates a strange juxtaposition of being undifferentiated and emotionally immature yet also parentified (treated like a friend or surrogate spouse). The circumplex model proposes four unbalanced relationship types: chaotically-disengaged (i.e., very high flexibility and very low cohesion), rigidly-disengaged (very low flexibility and very low cohesion), rigidly-enmeshed very low flexibility and very high cohesion, and chaotically-enmeshed (i.e., very high flexibility and very high cohesionAn unbalanced, chaotically-enmeshed family system encompasses individual family members who are emotionally over-involved. They have a strong sense of loyalty to the family, and do not possess many friendships or interests outside of the family. There is also a lack of family leadership, and with roles shifting between members within the family system, discipline and decision making are erratic. The emotional over-involvement and ambiguous family roles that are characteristic of chaotically-enmeshed families make it difficult for family members to adapt to the normal developmental transition .

**Psychological flexibility**

Psychological flexibility, or “the ability to fully contact the present moment and the thoughts and feelings without needless defense and, depending upon what the situation affords, persisting or changing in behavior in the pursuit of goals and values” , is a construct that is related to one’s ability to cope with psychological distress . Greater psychological flexibility is related to lower anxiety levels . As individuals interact with their environment, flexibility allows individuals to employ regulation processes that increases ability to accept present private experiences (i.e., thoughts and feelings), adapt to situational demands, balance competing needs, and behaviorally take action based on one’s valued direction . Psychological inflexibility refers to the unwillingness to accept present thoughts and feelings, and exhibiting ineffective behaviors that maintain or increase one’s struggles. Individuals who are psychologically inflexible are more likely to engage in ineffective strategies for responding to difficult thoughts and emotions, including negative judgement, rumination and dwelling, and guilt and shame Family relationships, especially parent–child relationships, can impact a child’s psychological flexibility. . Parenting that is perceived by adolescents as warm and democratic is associated with higher psychological flexibility. Parenting flexibility has also been shown to moderate the relationship between parent distress and child distress. Theoretically, there may be a cascade effect by which maladaptive family functioning may spillover into intrapsychic domains. In response to their own thoughts and feelings during interpersonal family distress, individuals are likely to employ psychologically inflexible strategies (i.e., rumination, negative judgement of thoughts and feelings), which may foster increased anxiety symptomology.

**Self-compassion**

Self-compassion refers to “being open to and moved by one’s own suffering, experiencing feelings of caring and kindness toward oneself, taking an understanding, nonjudgmental attitude toward one’s inadequacies and failures, and recognizing that one’s own experience is part of the common human experience” . Adopting a self-compassionate stance providess a framework for relating to oneself during psychological distress through the components of self-kindness, common humanity, and mindfulness. Self-kindness is the extension of kindness towards oneself rather than harsh judgement and self-criticism. Selfcompassion buffers anxiety levels through its positive effects on worry and brooding, a type of self-critical rumination about one’s distressful thoughts and feelings. Instead of becoming trapped in a self-critical rumination cycle, self-compassion effectively copes with emotional distress through enhancing emotional intelligence, heightening positive affect, and reducing negative affect. Instead of evaluating and modifying thoughts, emotional resilience is facilitated through the self-compassionate actions of accepting negative thoughts and emotions and extending a kind, patient, and encouraging tone towards oneself. Individuals from families with lower levels of conflict and more warmth tend to have higher levels of self-compassion suggesting that family relationships and experiences may act as a model for how individuals care for and support themselves. The lack of organization and leadership within the family system, combined with extreme emotional dependence and the generated guilt for doing things outside the family system, may spillover into intrapsychic processes, influencing levels of psychological flexibility and self-compassion. Fundamentally, psychological flexibility and self-compassion are regulation strategies to effectively handle difficult thoughts and emotions, including those triggeredby one’s family-of-origin. Unbalanced family environment can spillover into self-criticism and psychologically inflexible methods for managing this emotional distress (i.e., rumination, judgement of thoughts and feelings). The inability to cope with these difficulties may, in turn, raise anxiety levels. Balanced families manage stress more effectively than unbalanced typesbecause they are able to adapt to normative developmental stressors. Individuals from family environments that encourage autonomy and personal growth are able to develop increased self-efficacy

**Helicopter parenting,**

Helicopter parenting, an overinvolved parenting style, is characterized by giving excessive advice, solving problems, and involvement in their child’s emotional wellbeing to the point of enmeshment and limits autonomy-granting by parents, which inhibits opportunities to learn the necessary skills to become a self-reliant adult, such as the ability to effectively manage emotional and psychological distress. Children from chaotically-enmeshed families are at risk for utilizing non-self-compassionate and psychologically inflexible strategies to handle distress, such as self-criticism, negative judgements of one’s thoughts and feelings, and rumination. A cascade effect may occur by which distress within the family system may spillover into one’s ability to cope with heightened emotional and psychological distress. Due to the over-involved, dependent, and disorganized nature of chaotically-enmeshed families, parents may have difficulty supporting autonomy, which could limit the child’s ability to develop the skills to navigate this developmental period .

Unhelpful and unhealthy impacts on mental wellbeing can include

* *Increased emotional entanglement*

Individuals become overly entangled in other family members’ lives, activities, and emotions, leading to a heightened sensitivity to family stress.

* *Conditional or restricted access to family resources*

Enmeshed family members may have to forego autonomy to access family resources, potentially hindering individual independence.

* *Distress spillover*

In the absence of [clear boundaries](https://positivepsychology.com/boundaries-quotes-books/) or individual identities, distress and hostility spill over, leading to an almost constant state of distress within the family.

* *Heightened sensitivity to family instability and upset*

Children may become extremely sensitive to instability.

* *Loss of individual identity*

As boundaries become blurred, the individual’s sense of self becomes intertwined with other family members.

* *Emotional dependence*

Individual self-worth may depend on the approval and validation of others. Such emotional dependence can make developing the skills and autonomy needed to regulate emotions independently challenging.

* *Difficulty setting boundaries*

[Healthy boundaries](https://positivepsychology.com/great-self-care-setting-healthy-boundaries/) are difficult to form and maintain, making it difficult to assert oneself, say no, and prioritize individual needs.

* *Codependent behaviors*

Cycles of unhealthy relationships form that promote codependency.

* *Impact on other relationships*

Enmeshed individuals may struggle to form balanced, healthy relationships beyond the family.

*Mental health disorders*

People experiencing enmeshment may experience increased susceptibility to stress, burnout, and feeling overwhelmed.

Enmeshment impacts individuals differently depending on multiple contextual factors and can have complex effects on mental wellbeing and can even offer potential benefits when maternal relationship stability is high, while exacerbating the risk of mental health problems when it is low .

Common signs of enmeshment include

* 1. Difficulty making decisions without family input  
  2. Feeling responsible for others’ emotions  
  3. Lack of privacy or personal space  
  4. Excessive involvement in each other’s lives  
  5. Guilt when pursuing individual interests

Humans are naturally driven to seek closeness to significant others in times of distress, a behavior rooted in the attachment system. Through attachment experiences, along with caregiver sensitivity and attunement, a child develops mental representations, or working models, of others and of self, that will work as a matrix for future. There are variations in how individuals connect with significant others in their lives, and these individual differences are referred to as attachment styles. Being sensitive and respond to what the child needs leads to secure attachment characterized by positive mental representations of self and others, a sense of self-worth, and trust in others. Insecure attachment can be described in terms of two primary dimensions: anxiety and avoidance. Attachment anxiety conveys a propensity for anxiety and alertness when faced with rejection and abandonment, whereas attachment avoidance relates to discomfort with closeness to and dependency on others. Parents who are characterized by insecure attachment, exhibit a markedly increased risk of engaging in child maltreatment and physical abuse. Enmeshment and Undeveloped-Self in the domain of Impaired Autonomy and Performance, entails excessive emotional involvement and closeness with one or more significant others, often a parent, sibling, or a partner. Enmeshed individuals feel indispensable to one another, and personal boundaries seem unreasonable.The Undeveloped-Self part of the schema refers to the lack of individual identity and it is often experienced as “emptiness, lack of direction, or even questioning one's existence”

The consequences of Enmeshment and Undeveloped-Self range from difficulties in differentiation and separation, increased internalizing and externalizing problems, to difficulties in social and occupational functioning, maladaptive relationship behaviors (e.g., possessiveness, jealousy, coercive control) and increased depression and anxiety On the other hand, individuals that self-sacrifice, have an excessive focus on the needs of others; they experience self-sacrifice as voluntary, to prevent feeling guilty or selfish, hurt others or to avoid retaliation. Traumatized child may hold a view of the self as inadequate or defective, and therefore believe that parental abuse and neglect are justified and unquestionable, or that its suffering is deserved Traumatic experiences are also linked to overwhelming emotions and dissociative reactions which can impact an individual's experience of continuity between past, present, and future and hinder the ability to create a consistent sense of identity. Integrating different experiences and elements of the self, is necessary for physical and psychological well-being .Trauma affects a clear sense of self, with emotional abuse and neglect having the strongest correlation with self-concept clarity . Childhood trauma refers to recurring and ongoing aversive events, most often of interpersonal nature and within a child's caregiving system .

Meta-analytic studies show a strong association between childhood trauma and various mental health outcomes, including suicidal ideation, depression, anxiety, eating disorders and personality disorders, across both general and clinical population  . Furthermore, research highlights the profound impact of the initial caregiver-child attachment in shaping expectations and behavior in later life. Humans are naturally driven to seek closeness to significant others in times of distress, a behavior rooted in the attachment system . Through attachment experiences, along with caregiver sensitivity and attunement, a child develops mental representations, or working models, of others and of self that will work as a matrix for future interactions  There are variations in how individuals connect with significant others in their lives, and these individual differences are referred to as attachment styles. Being sensitive and respond to what the child needs leads to secure attachment characterized by positive mental representations of self and others, a sense of self-worth, and trust in others . Insecure attachment can be described in terms of two primary dimensions: anxiety and avoidance.

Attachment anxiety conveys a propensity for anxiety and alertness when faced with rejection and abandonment, whereas attachment avoidance relates to discomfort with closeness to and dependency on others. Parents who are characterized by insecure attachment, exhibit a markedly increased risk of engaging in child maltreatment and physical abuse, potentially perpetuating their attachment style within their offspring .Traumatic experiences are also linked to overwhelming emotions and dissociative reactions which can impact an individual's experience of continuity between past, present, and future and hinder the ability to create a consistent sense of identity. Integrating different experiences and elements of the self, is necessary for physical and psychological well-being trauma affects a clear sense of self, with emotional abuse and neglect having the strongest correlation with self-concept clarity. Self-coherence is defined as the necessity to feel psychologically intact and rooted, experiencing the self as integrated, and the world as meaningful in relation to the person. These two sub-aspects are called identity and meaning the idea that the clarity of one's concept of self is a core emotional need, deviates from the developmental perspective on identity formation which views identity as a result of secure or earned-secure attachment I.e., a consistent self-concept is achieved when needs are met and a secure attachment and a clear sense of self are achieved. Conversely, when an attachment figure is source of abuse and neglect, it can cause a conflict between approach and avoidance in the child, with the child seeking a connection through submission or self-sacrificing behaviors, disregarding their own needs (291-293)

**Schema Theory**

Schema (plural: schemas or schemata) is an organized unit of knowledge for a subject or event based on past experience. Individuals access schema to guide current understanding and action. Information that does not fit into the schema may be comprehended incorrectly or even not at all. Schema theory is a branch of cognitive science concerned with how the brain structures knowledge. A schema is an organized unit of knowledge for a subject or event. It is based on past experience and is accessed to guide current understanding or action. Schema Theory posits that childhood trauma and unmet emotional needs lead to the formation of Early Maladaptive Schemas (EMS). Schemas are dynamic – they develop and change based on new information and experiences and thereby support the notion of plasticity in development. Schemas guide how we interpret new information and may be quite powerful in their influence. Schemas, or schemata, store both declarative (“what”) and procedural (“how”) information. Declarative knowledge is knowing facts, knowing that something is the case; procedural knowledge is knowing how to do something – with no conscious ability to describe how it is done and values. For example, a house may be described in terms of its materials, such as wood and its parts, such as rooms.

Materials and parts, are the house schema’s slots and wood and rooms are the slot values. Slots may have default values (house purpose: to live in) though houses may be places of worship or museums. Schemas may have parent and child relationships with other schemas which inherit or pass on characteristics. A special slot in each schema is a slot, and points to the superset. Schemas allow writers and speakers to make assumptions about what the reader or listener already knows. Schema theory is a branch of [cognitive science](https://www.simplypsychology.org/cognitive.html) concerned with how the brain structures knowledge. Schema theory, that offers a comprehensive cognitive framework, has significantly influenced our understanding how individuals organize and interpret and store information, impacting learning, memory, and academic achievement. schema theory suggests that cognitive structures, or schemas, serve as mental frameworks guiding the organization and interpretation of incoming information. They are instrumental in shaping how individuals perceive, interpret, and integrate new information, thus playing a pivotal role in memory processes Innovations in schema theory have broadened its applicability, illustrating its impact on various aspects of cognition and emotional well-being. The interplay between cognitive abilities, social and emotional factors, and external influences affect various cognitive processes, including learning and memory. Schema theory offers a robust cognitive framework that elucidates how individuals organize and process information by deploying mental structures known as schemas. Schema theory posits that schemas are cognitive templates or frameworks that enable individuals to interpret and make sense of incoming information. These schemas are not static; they evolve based on an individual's prior experiences, knowledge, and cultural background influencing perception, memory, and thought processes.

Schemas, are interconnected concepts, beliefs, and expectations specific to domains such as objects, events, people, or situations. This interconnectedness allows for theswift processing and interpretation of new in missing details based on their existing knowledge and anticipate future events. This schema activation facilitates the assimilation of further information into existing knowledge structures, underscoring the significance of schemas in cognitive processing. Schemas significantly contribute to memory processes by aiding in the encoding and retrieval of information. They direct attention and memory recall towards schema-relevant details, enabling individuals to encode and remember information that aligns with their existing knowledge structures more effectively. Schema theory offers a comprehensive cognitive framework elucidating how individuals organize, process, and interpret information from their environment. This theory posits that mental structures, known as schemas, serve as the bedrock for organizing knowledge, beliefs, and expectations about various concepts, objects, events, or situations. Based on prior experiences, cultural influences, and individual learning processes, schemas embody cognitive frameworks or mental representations that encapsulate organized knowledge. Central to the theory is that schemas function as cognitive templates, guiding individuals in making sense of the world. These templates offer a structured approach for interpreting new information, categorizing, analyzing, and predicting phenomena based on pre-existing knowledge structures Schemas are pivotal in the efficiency of information processing, enabling swift categorization of incoming data within relevant mental frameworks, inference-making, and gap-filling with assumed knowledge. This process significantly influences attention and memory, directing focus towards information that aligns with existing schemas and potentially neglecting or misinterpreting discordant data.

Schemas are dynamic, evolving entities that undergo modification and expansion to assimilate new experiences and information, views perception as a constructive activity molded by the interplay between incoming stimuli and pre-established schemas. This perspective emphasizes the human propensity to organize information around critical dimensions, such as gender, underscoring cognition's innate classification and organization tendencies Its implications extend to psychology, where it aids in understanding the correlation between maladaptive cognitive patterns and psychological well-being. Schema theory's application. The study of genetic algorithms highlights. Its theoretical underpinnings in explaining their effectiveness. It provides insights into the impact of mood on questionnaire responses, further demonstrating how schemas influence susceptibility to psychological disorders. Schema theory presents a robust framework for understanding the intricacies of perception, cognition, learning, and psychological well-being and contributing to a more nuanced understanding of human cognition and behavior.

Schema theory consists of several key components and processes contributing to understanding how schemas operate in cognitive processes. These components and processes include schema construction, activation, assimilation, accommodation, and schema-driven information processing. experiences and interactions with the environment. Individuals construct schemas based on their previous knowledge, cultural background, and personal experiences. Schema construction involves organizing and integrating information into coherent cognitive structures and processing. Environmental cues or the specific task or situation triggers activation. Activated schemas guide attention and influence how individuals perceive and interpret new information and schemas. Assimilation allows individuals to make sense of new information based on their prior knowledge and experiences. To incorporate further information that does not fit within their pre-existing knowledge structures and challenges or conflicts with existing schemas, Accommodation is necessary for the individuals to adapt their cognitive frameworks and accommodate the new knowledge on cognitive processes, such as attention, memory, and interpretation. Schemas guide attention toward schema-relevant details, enhance memory recall for schema-consistent information, and influence the interpretation and recall of information by filling in missing details based on schema expectations. These key components and processes of schema theory provide insights into how schemas influence cognitive and information processing. Schema construction and activation shape the mental framework, while assimilation and accommodation enable the integration of new information. Schema-driven information processing affects attention, memory, and interpretation, contributing to individuals' understanding of the world.

Within schema theory, cognitive structures play a fundamental role in the organization and processing of information. These structures facilitate the efficient encoding, storage, and retrieval of knowledge. Two critical cognitive structures within schema theory are schemas and scripts. Schemas consist of knowledge about specific concepts, objects, events, or situations and interconnected concepts, beliefs, and expectations related to a particular domain. They provide a framework for understanding and interpreting incoming information, helping individuals make sense of the world around them. Schemas assist in filling in missing information and guiding attention to relevant details. They help individuals categorize and interpret new information by matching it with their existing schemas. Schemas influence memory processes, as individuals are more likely to remember schema-consistent details and tend to distort or forget schema-inconsistent information routines. Scripts represent the expected order of actions, behaviors, and interactions associated with specific events or situations. For example, an individual may have a script for going to a restaurant, which includes expectations about entering, being seated, ordering, and paying. Scripts guide individuals in anticipating and understanding the typical flow of events within specific contexts. They help individuals predict and interpret others' behaviors and actions, facilitating efficient information processing. These cognitive structures, schemas, and scripts play a crucial role in the organization and processing of information. They provide a mental framework that assists in interpreting and integrating new information, filling in missing details, and guiding attention and memory processes. Individuals efficiently navigate and understand the complex world by utilizing these cognitive structures. Activated schemas provide a cognitive framework that helps individuals make sense of new information based o their existing knowledge structures. This activation allows individuals to

process and integrate new knowledge into their current schemas quickly and efficiently it to existing knowledge structures. Individuals connect and identify patterns by integrating new information into schemas, promoting deeper comprehension and knowledge organization and acquisition. When individuals possess relevant schemas, they more easily acquire and comprehend further information within that domain Schemas also facilitate the retrieval and application of knowledge, allowing individuals to draw upon their existing schemas when solving problems or engaging in critical thinking tasks

Schema theory is crucial in understanding how individuals learn and process new information. Individuals acquire knowledge and make sense of the world by activating, integrating, and utilizing schemas to guide their understanding and interpretation of the information. Activated schemas provide a cognitive framework that helps individuals make sense of new information based on their existing knowledge structures. This activation allows individuals to process and integrate new knowledge into their current schemas quickly and efficiently. Individuals make connections, identify patterns, and build a coherent knowledge base by integrating new information into schemas.This process promotes deeper comprehension and meaningful learning experiences and knowledge acquisition. When individuals possess relevant schemas, they more easily acquire and comprehend further information within that domain. Schemas also facilitate the retrieval and application of knowledge, allowing individuals to draw upon their existing schemas when solving problems or engaging in critical thinking tasks. This process facilitates comprehension, knowledge organization, and the formation of meaningful connections.

When individuals encounter new information, relevant schemas are activated to guide their understanding and interpretation. Research has shown that activating appropriate schemas improves comprehension and memory recall. Activated schemas guide attention toward schema- relevant details and help individuals interpret new information within their existing knowledge structures. Schemas facilitate the integration of new information by relating it to existing knowledge structures. This integration allows for the formation of meaningful connections and the organization of knowledge. Explicit connections between new material and existing schemas facilitate comprehension and knowledge transfer Individuals enhance comprehension, retention, and knowledge organization by leveraging existing schemas and connecting them to further information. Schemas play a fundamental role in knowledge acquisition by providing a cognitive framework for organizing, interpreting, and integrating new information. They facilitate acquiring and making sense of new knowledge within relevant domains. Activated schemas provide a cognitive structure that helps individuals categorize and interpret further information based on their existing knowledge structures. This activation allows for the efficient processing and integration of new knowledge their schemas, expanding and refining their understanding. This process of assimilation allows for the incorporation of new knowledge into existing cognitive frameworks, promoting coherence and meaningful connections cognitive structure for interpreting and categorizing new information.

Organization and Integration of New Information: Schemas facilitate the organization and

• Activation of Relevant Schemas: When individuals encounter new information, relevant schemas

Research has shown that individuals with relevant schemas more readily comprehend and remember further information within that domain Schemas help individuals organize their knowledge, allowing for the identification of patterns, relationships, and principles and acquisition by influencing attention and memory processes. Schemas guide attention toward schema-relevant details, helping individuals focus on important information while filtering out irrelevant details Schemas also facilitate memory recall by providing a framework for encoding and retrieving information .Schema theory provides insights into how schemas influence memory processes, including encoding, retrieval, consolidation, and the potential biases and distortions introduced by schemas. Understanding the relationship between schema theory and memory sheds light on how individuals remember and recall information providing a framework for organizing and interpreting new information. Individuals are more likely to encode schema-consistent information because it fits well within their existing knowledge structures. This facilitates encoding and memory recall for schema-consistent details individuals attempt to recall information, activated schemas help direct attention toward schema- relevant details. This schema-driven retrieval process enhances memory recall for information consistent with existing schemas. It also leads to memory biases and distortions, as individuals fill in missing details based on schema expectations. Individuals tend to remember schema-consistent information more accurately and vividly than schema-inconsistent information. Schemas shape individuals' interpretation and reconstruction of past events, leading to memory errors and distortions.

• Memory Consolidation and Organization: Schemas aid in the consolidation and organization of

Information consistent with existing schemas is more easily integrated into long-term memory and connected to relevant knowledge structures. Schemas provide a cognitive frameworkthat helps individuals organize and retrieve information, promoting efficient memory storag and retrieval processes. Schema theory provides insights into how schemas influence encoding and retrieval processes in memory. The encoding process involves the initial acquisition and processing of information, while the retrieval process involves accessing and recalling information from memory. Understanding how schemas impact these processes sheds light on memory formation and recall providing a cognitive framework for organizing and interpreting new information. When individuals encounter schema-consistent information, it fits well within their existing knowledge structures, making it easier to encode. Research has shown that individuals are more likely to remember schema-consistent details than schema-inconsistent details Schema-consistent information is more easily integrated into existing schemas, promoting efficient encoding and storage.

Schemas play a significant role in memory consolidation, affecting how information is stored and organized in long-term memory. Memory consolidation refers to the process by which newly acquireinformation becomes more stable and integrated into long-term memory. The influence of schemas on memory consolidation is evident in various aspects. This process of organization and integration enhances memory consolidation by allowing for the incorporation of new knowledge within relevant cognitive frameworks sense of new information by connecting it to existing knowledge. This coherence and connectivity within schemas facilitate memory consolidation by creating meaningful associations and links between related pieces of information. Schemas enable individuals to store and retrieve information more coherently and organized cues. The activation of schemas during retrieval serves as a cue to access related information stored in long-term memory. When individuals attempt to recall information, activating relevant schemas guide the retrieval process by directing attention toward schema-consistent details and facilitating the reconstruction of memory based on existing knowledge structures. Schema theory highlights the potential for memory biases and distortions that occur as a result of schema-driven processes. Schemas shape the encoding, retrieval, and reconstruction of memory, leading to biases and distortions in how information is remembered. Understanding these biases is crucial for a comprehensive understanding of memory processes. This bias accurately recalls schema-consistent details, while schema-inconsistent details are overlooked or forgotten.When individuals recall past events or information, they unknowingly fill in gaps with schema-consistent information that was not encoded initially. This schema-filling bias leads to memory reconstruction with schema-consistent but inaccurate details leading to memory biases based on existing beliefs and expectations. Stereotypes associated with particular groups or concepts affect the encoding and retrieval of information. Metacognitive strategies, asmuch as setting goals, monitoring progress, and self-evaluating, enhance cognitive performance by promoting self-awareness and adaptive learning. training has been shown to enhance working memory, attentional control, and cognitive flexibility. Enhancing memory through everydaystrategy helps improve the retention and recall of information.

• Schema-Consistent Recall Bias: Schemas lead to a bias in memory recall, where individuals are

Schema theory, emphasizes the role of existing knowledge structures (schemas) in memory processes, Embedding information within a relevant context aids schema activation and improves memory encoding and retrieval. Recalling information from memory strengthens neural connections and improves long-term retention. Creating mental images provides additional retrieval cues and strengthens associations within schemas. Grouping related items within a schema allows for easier recall and reduces cognitive load. Schema theory highlights the role of prior knowledge, schemas, and their activation in shaping comprehension, knowledge integration, and academic achievement. The practical implications of schema theory extend to various domains, including education, psychology, and communication. Schemas are conceptual frameworks that represent information, assumptions, and expectations regarding certain ideas or circumstances A psychological framework called schema theory, commonly referred to as cognitive schema theory, describes how people organise and interpret information from their environment. It sheds light on how our interpretation of diverse ideas, circumstances, and experiences is shaped by our knowledge, beliefs, and expectations. The word "schema" refers to mental frameworks or structures that embody our understanding and expectations of many facets of the outside world. Through our experiences, cultural influences, and social interactions, these schemas are formed. They act as cognitive frameworks that aid in our understanding of the massive quantity of information we are exposed to every day. Schemas direct our attention, interpretation, and memory while playing a vital part in cognitive processes. They enable us to classify and interpret incoming information swiftly using our prior knowledge and expectations. For instance, when we come across a familiar event or item, we activate the appropriate schemas to interpret the circumstance and forecast the anticipated outcome.

According to the schema theory, schemas have an impact on several cognitive processes. By directing our attention and how we interpret stimuli, they have an impact on perception. They also affect memory encoding and retrieval because our expectations and past knowledge shape what we remember and how we remember it. Schemas also affect how decisions are made. They have an impact on how we weigh our alternatives and form opinions in accordance with our expectations and beliefs. For example, we depend on schemas relating to our expectations of a good workplace, compensation, and job tasks when assessing a job offer. Schemas have ramifications for not just cognitive processes but also social cognition. They influence how we perceive social norms, stereotypes, and positions in society. Schemas affect our expectations for social interactions as well as how we view and interpret other people's behaviour. Although schemas typically aid in our ability to absorb information quickly, they may also result in cognitive biases and distortions. Confirmation bias is a cognitive bias in which we selectivelypay attention to and interpret data that supports our preexisting ideas and expectations while disregarding contrary evidence. Schemas may contribute to confirmation bias Knowing about schema theory offers useful insights into how people take in, process, and react to their environment.

Schemas are dynamic entities that are always being updated and improved as we learn new knowledge and change how we see the world. They are malleable and versatile, enabling us to incorporate new experiences into pre-existing schemas or develop new schemas in response to novel circumstances Schemas' impact on perception and attention is a crucial component. Our schemas influence what we focus on and how we process sensory data. schemas aid in directing our memory-related activities. By offering a cognitive framework for encoding and retrieval, they assist us in organising and retrieving information. It is simpler for us to retain and recall new information when it corresponds to our preexisting schemas. Information that does not match our schemas, however, could be harder to recall or might be misrepresented to support our preconceived notions. Schemas may also affect how we act and what choices we make. They influence our expectations and direct our behaviour in a variety of situations Schemas don't always accurately reflect reality, however. They may result in cognitive distortions and biases. For instance, confirmation bias happens when we only look for and consider data that supports our pre-existing ideas, dismissing conflicting evidence. These prejudices may impair our capacity to form unbiased judgements. Schemas are mental models that influence how we see, understand, and retain information. They are essential for cognitive processing, focus, memory, and judgement. Recognising and addressing biases and cognitive distortions that may affect our relationships and knowledge of the world may be made easier by comprehending the nature and effect of schemas, which can provide insightful information about human cognition and behaviour

Schemas also known as schemata or schema theory is a collection of concepts relating to cognitive structures that aid in the organisation, presentation, evaluation, and application of human knowledge and abilities by segmenting accessible data into useful pieces. As it organises prior experiences to comprehend new circumstances and to make unexpected positions and settings more familiar for example, by decreasing ambiguity and improving comprehension this constructivist approach is useful in many facets of contemporary life, including management. . A psychological framework called schema theory offers important insights into how the brain works and how people behave. It implies that people use mental models known as schemas to categorise and understand information they receive from their surroundings. Schemas function as cognitive frameworks or templates that assist us in classifying, comprehending, and organising the environment around us Schema Theory's capacity to describe how people effectively receive and integrate information is one of its primary advantages. Schemas help us foresee the future, fill in the blanks, and direct our attention to the important aspects. Our ability to properly traverse our surroundings is made possible by our efficient cognitive processing, which saves time and resources.

Schema Theory's effects on memory encoding and retrieval are yet another benefit. It is simpler to encode and retrieve related information when information is organised in memory using schemas. When we come across fresh knowledge that fits with our preconceived notions, it reassemble memories by filling in the blanks with information we already know and anticipate. The function of schemas in shaping perception and interpretation is also highlighted by schema theory. By directing our focus towards schema-relevant elements and affecting how we interpret ambiguous inputs, our schemas influence how we perceive and interpret sensory information. This affects how we see the world and may result in prejudice and preconceptions. Understanding how people read and react to social signals depending on their schemas may help in interpersonal interactions. Overall, the schema theory gives insightful perspectives on how people organise their knowledge, absorb information, and understand their environment. Effective cognitive processing, .

Schemas may be categorised as person schemas, group schemas, self-schemas, role schemas, event schemas, and content-free schemas, to name just a few. Person schemas aid in understanding human behaviour by providing details on distinct sorts of people. Stereotypes about a group's membership, such as its members' racial, ethnic, and religious backgrounds, are referred to as group schemas. Selfschemas relate to personal self-awareness that influences a person's behaviour to be congruent with their thoughts and beliefs. Role schemas focus primarily the vocational responsibilities or roles in different organisations, teams, schools, or clubs and are linked to knowledge on social roles. Event schemas, also known as scripts or event sequences, provide the user information about the sequence of events in ordinary activities as well as in certain unique or formal circumstances, including weddings, funerals, or job interviews. The scripts include the topic, typical roles, admission requirements, and the sequence of events in terms of event sequence components. The information regarding the connections between entities and components is dealt with by content-free schemas, but not the content itself. They place emphasis on the connections between individuals and objects as well as how these connections and interdependence shape systems. Organizational Schemas Self-in organization schemas, person-in organization schemas, organisation schemas, object/concept-in organization schemas, and event-in-organization schemas are examples of in-organization schemas.

Self-in-organization schemas relate to how people see their personalities, values, roles, and behaviour in relation to those in organisations. By taking into consideration one's own viewpoint on his or her place within the organisation, these schemas assist people in responding to organisational impulses. Personin-organization schemas are the recollections, viewpoints, and expectations about certain persons or people groupings. These schemas categorise persons according to numerous organisational schemas, such as their place in a hierarchy, in order to assist people grasp organisational reality. Organisational schemas make reference to how people view organisations, reflecting how organisational culture is evident in workers' or stakeholders' cognition. The understanding of organisational social gatherings is related to event-in-organization schemas. They could include occasions like company anniversaries or public holidays. Since social and human elements shape the schemas of specific organisations, both internal organisational characteristics and environmental factors outside the organisation affect the strength of the schemas. A person's attention or motivation, prior experiences and expectations, upbringing, education, and social/professional circumstances may all be included when considering the personal realm of organisational schemas. Knowledge schemas or scripts, which may be classified as weak or strong, depend on how powerful they are. While strong scripts also aid in predicting the future sequence of events, weak scripts just give information on the behavioural occurrences that are likely to occur. Knowledge schemas may be employed subconsciously automatic script processing or actively controlled script processing while processing scripts.

Environmental elements, such as the socialcognitive processes underpinning human vision, memory, decision-making, and social cognition may be better understood via the perspective of schema theory. It emphasises how our perception of the environment is shaped by our past knowledge, expectations, and cognitive processes. We may improve our cognitive flexibility, confront prejudices, and approach information and events with a more open and informed mentality by looking at and understanding our own schemas.Schema Theory is a cognitive framework that explains how individuals organize and integrate new information with their existing knowledge stored in long-term memory. According to this theory, learning occurs when learners activate relevant schemata—mental structures that represent related concepts and experiences—allowing them to make sense of new texts or situations. Schemata function like "slots" in the brain, where each slot holds interconnected information, guiding learners' expectations and interpr hen they encounter new material.Schema Theory emphasizes the role of prior knowledge in comprehension. It suggests that learners who can relate new knowledge to their existing schemata are more likely to understand and retain the information. Various types of schemata exist, including content, textual, and linguistic schemata, each serving distinct functions during the learning process. (294-295)

**constructivist perspective**

there are two major strands of constructivist perspective, (a) constructivist perspective and (b) social-cultural perspective (Socio-constructivist perspective). Constructivist and sociocultural theories, propose that individuals actively construct their knowledge and schemas through exploration, assimilation, and accommodation These perspectives highlight the dynamic nature of knowledge construction and the role of social interactions in shaping cognitive development. They emphasize that knowledge and learning are deeply embedded in the social and physical contexts in which they occur. Social constructivism is a theory of knowledge in sociology and communication theory that examines the knowledge and understandings of the world that are developed jointly by individuals. This theory assumes that understanding, significance, and meaning are developed in coordination with other human beings. The most important elements in this theory are

(a) the assumption that human beings rationalize their experience by creating a model of the social world and the way that it functions and,

(b) the belief in language as the most essential system through which humans construct reality

• Situated Cognition: Situated cognition theories argue that cognition is situated and context-

Social constructivism suggests that knowledge is first constructed in a social context and is then internalized and used by individuals Social constructivists believes that the process of sharing individual perspectives-called collaborative elaboration results in learners constructing understanding together and this construction cannot be possible alone within individuals. Adults convey to children how their culture interprets and responds to the world.They show the meaning they attach to objects, events, and experiences. They provide the child with what to think (the knowledge) and how to think (the processes, the tools to think with).Infants are born with basic abilities for intellectual development, called “elementary mental functions.” These include attention, sensation, perception, and memory.Through interaction within the sociocultural environment, elementary functions develop into more sophisticated “higher mental functions.”Higher mental functions are advanced cognitive processes that develop through social interaction and cultural influences. They are distinct from the basic, innate elementary mental functions.

Unlike elementary functions (like basic attention or memory), higher functions are:

* **Conscious awareness**: The individual is aware of these processes.
* **Voluntary control**: They can be deliberately used and controlled.
* **Mediated**: They involve the use of cultural tools or signs (like language).
* **Social in origin**: They develop through social interaction.

Examples include language and communication, logical reasoning, problem-solving, planning, attention control, self-regulation, and metacognition.Cultural tools are methods of thinking and problem-solving strategies that children internalize through social interactions with more knowledgeable members of society.These tools, such as language, counting systems, mnemonic techniques, and art forms, shape the way individuals think, problem-solve, and interact with the world.Cultural tools, particularly language, influence the development of higher-order thinking skills.Other tools include writing systems, number systems, mnemonic techniques, works of art, diagrams, maps, and drawings.These tools are products of sociocultural evolution, passed down and transformed across generations.Each culture provides its children with tools of intellectual adaptation that allow them to use basic mental functions more effectively.These tools, along with social interaction, contribute to the development of higher mental functions through a process of internalization.This historical and cultural embeddedness means that tools carry within them the accumulated knowledge and practices of a particular community.For example, biological factors limit memory in young children. However, culture determines the type of memory strategy we develop. The child seeks to understand the actions or instructions provided by the tutor (often the parent or teacher) and then internalizes the information, using it to guide or regulate their performance.Modern developmental psychology recognizes that cognitive and emotional development are deeply intertwined.

* The sociocultural perspective, is exactly what its name suggests. It’s the idea that the

Society and groups that an individual belongs to are what influences development, thoughts, and behavior. Situated cognition challenges the notion of schema as a generalized cognitive structure and instead focuses on the situated nature of knowledge activation and application This perspective highlights the importance of considering the context in which cognition occurs and the role of environmental and social factors in shaping cognitive processes. Distributed processing models, propose an alternative to the information-processing view of cognition. These models emphasize the interconnectedness of neural networks and the distributed representation of knowledge. Instead of relying on rigid schema structures, connectionist models suggest that knowledge is distributed across multiple nodes and connections, with activation patterns determining cognitive processes probabilistic reasoning and updating beliefs. These approaches emphasize the role of prior knowledge, but they frame it in terms of prior beliefs and their adjustment based on new evidence. They enrich our understanding of cognition beyond the traditional schema-based approach and encourage further exploration and integration of different theoretical frameworks. Enhancing cognition through everyday strategy is beneficial for improving memory, attention, and overall cognitive performance. (296-297)

**the dual-coding theory (DCT)**

The dual coding theory suggests that using visual and verbal information facilitates the creation of multiple retrieval cues organize and store information in memory more efficiently, making it easier to retrieve and process . According to the dual-coding theory (DCT), human brain uses both verbal and visual information for the storage and representation of information, but the human mind processes this information differently with the help of two separate channels Based on long-term memory, the image system and semantic system., Representation and semantics are two parallel and related cognitive systems. Representation system uses representation code to store information and semantic system stores information with the help of semantic code.People’s visual representations are particularly developed, and they can be activated by relevant inspirations, respectively. Semantic code is an abstract representation of meaning. Some discrete materials are organized due to meaningful connections, making memory relatively easy.Two processing systems with independent but interrelated functions in the human brain: one processing system is based on language, and the other processing system is based on image. Image system is specific for representing and processing nonverbal objects and events. It is composed of image representations with associative relationship. Cognition is supported by two special representation systems, which come from experience and have obvious differences in expressing and processing information about nonverbal objects, events and linguistic information .

* • Connectionist Models: Connectionist models, also known as neural network models or parallel

• Assimilation: Assimilation is incorporating new information into existing schemas. Individuals integrate further details into their existing knowledge structures when they align with pre-existing

• Schema-Driven Information Processing: Schema-driven information processing refers to the

• Scripts: Scripts are a specific type of schema that organizes knowledge about events, sequences, or

• Stereotype and Preconception Effects: Schemas are influenced by stereotypes and preconceptions,

• Schema Construction: Schema construction refers to the development of schemas through

• Schema Activation: Schema activation occurs when a relevant schema is brought to the forefront of

• Schemas: Schemas are cognitive frameworks or mental representations that organize and categorize

Enmeshment can be deﬁned as the experience of confusion of one’s separateness from

others, a diminished sense of self that includes a loss of autonomy in relationships, and

an inability to fully experience, understand, and value one’s own thoughts, feelings,

and needs in the context of relationship.

The concept of enmeshment also has its origins in family therapy models in the

1970s. The concept appeared more prominently within the structural family therapy

model (Minuchin, 1974). Minuchin (1974) proposed that family systems were organ-

ized into subsystems (the spouse subsystem, the parental subsystem, and the sibling

subsystem). These subsystems carried a set of boundaries which deﬁned roles and par-

ticipation in family functioning. These boundaries exist on a linear continuum, rang-

ing from diﬀuse boundaries (enmeshed) to rigid boundaries, on opposite ends of the

continuum. While diﬀuse and rigid boundaries are viewed as dysfunctional, the normal

range boundaries, in the middle of the continuum, are ideal for facilitating functional

relating and adaptation.

In the study of family relationships, however, it is vital to

consider the interaction of these forces and to recognize that

the mother–child connectedness is not only symbiotic but

also represents the beginnings of the reciprocity that is a

characteristic of familial interactions (Parker, 1995).

According to Love (1990), the mother as well as the child

thrives on the physical contact, intimacy, and unconditional

love that is reminiscent of parent–infant interactions. Love

further described the mother–infant relationship as an emo-

tional attachment that often requires offsetting forces to keep

it within healthy bounds. It is precisely this emotional fusion,

or at least the potential for it, that parents are charged with

resolving by engaging in behaviors that are designed to pro-

mote and permit the emergence of individuality and healthy

emotional development (Kerr, 1988). In other words, it is the

responsibility of the parent to provide the child the “secure

base from which the child can venture forth into the wider

world and return to as a safe haven of reassurance”

(Schwartzman, 2006, p. 226

• Accommodation: Accommodation occurs when individuals modify existing schemas or create new

Schema Integration in Learning: Schemas facilitate the integration of new information by relating

• Schemas and Knowledge Acquisition: Schema theory emphasizes the role of prior knowledge in

• Organization and Integration of Information: Schemas facilitate the organization and integration

.

• Bayesian Approaches: Bayesian approaches to cognition propose that cognitive processes involve

• Dual Coding: Combine visual and verbal representations to enhance understanding and memory.

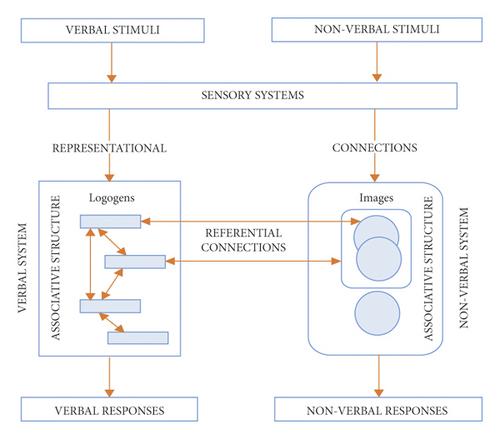
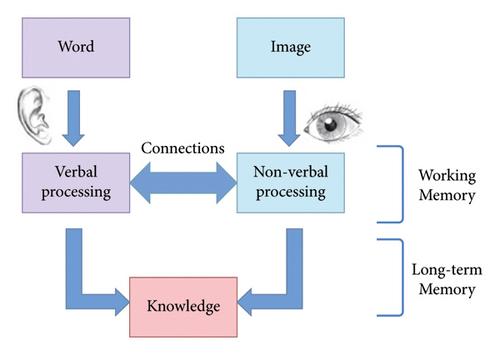


Figure 45.explains the processing of the cognitive system, which consists of verbal and nonverbal systems. It also consists of three levels of processing, which includes representational processing, referential processing, and associative processing. The top of the model shows that people’s cognitive process initially begins with sensory systems of verbal and nonverbal stimuli from the real environment. , the organization of the verbal system is sequential and hierarchical. It indicates that the verbal system works like a network. On the other side, the images in the nonverbal system are constructed in an overlapping and nested way.



• Metacognitive Strategies: Engage in metacognition by reflecting on your thinking processes.

Fig. 46. The above diagram represents the cognitive system. There are two cognitive subsystems: one dedicated to the representation and processing of nonverbal objects and events (images) and the other to language.

According to DCT, mental representations are associated with theoretically distinct verbal and nonverbal symbolic modes and retain properties of the concrete sensorimotor events on which they are based . The verbal system contains visual, auditory, articulatory, and other modality-specific verbal codes (e.g., representations for such words as book, text, livre, school, teacher, learn, strategy, mathematics, and worry). These word-like codes are arbitrary symbols that denote concrete objects and events, as well as abstract ideas. Verbal codes retain their separate and discrete identities even when connected in hierarchies or other associative networks. verbal representations are generally processed in a serial or sequential manner. . Nonverbal representations include modality-specific images for shapes (e.g., a chemical model), environmental sounds (e.g., school bell), actions (e.g., drawing lines or pressing keys), skeletal or visceral sensations related to emotion (e.g., clenched jaw, racing heart), and other nonlinguistic objectsSuch imaginal representations are analogous or perceptually similar to the events that they denote, rather than being arbitrary symbols. That is, mental images for "book" have visual, tactual, and other perceptual qualities similar to those evoked by the referent objects on which the images are based. Similarly, mental images evoked by emotionally laden words or phrases (e.g., "I like my teacher" or "I hate math") have visceral properties similar to those experienced when one is actually in the presence of the affective object. In contrast to verbal processing, which is sequential, nonverbal representations can encode information in parallel or simultaneously complex images can integrate the parts of events, objects may "lose" their separate identities and become spatially embedded or nested in the whole imaginal structure. Mental images are also amenable to dynamic spatial transformations that are not possible with verbal representations.

DCT's other structural assumptions concern the connections that link verbal and nonverbal representations into a complex associative network . Links between the two systems are called referential connections. They join corresponding verbal and imaginal codes and potentially allow such operations as imaging to words and naming to pictures. . Within the nonverbal system, associative connections join images to other images in either the same or different sensory modalities. The development and activation of verbal and imaginal associative structures are governed by DCT's processing assumptions. A basic premise is that individual verbal and imaginal representations vary in their activity levels, with some representations highly active and others depressed at any given time. Strong activity may be associated with conscious nonverbal and verbal experiences although arousal of codes does not always lead to conscious experiences. Active mental representations can in turn activate associatively related nodes in the network, and this spreading activation results in complex patterns of arousal among the representations in the network.

Metaphorically, one can think of human cognition as a constantly changing landscape with elevated areas (peaks) indicating aroused mental codes and low-lying areas (valleys) indicating depressed codes. The particular shape of the landscape depends on complex and subtle associative mechanisms.With respect to the development of mental representations and their interconnections, DCT emphasizes the central role of past experience. One way in which the importance of experience reveals itself is through idiosyncratic and context-dependent reactions to environmental events. Although similar experiences promote common mental structures, variability in individual experiences means that mental representations and their interconnections can vary from person to person, depending upon people's specific history with the elements in the network. Even given common experiences, the development of connections vary with the accessibility of existing codes; According to DCT, the relative activation of the nonverbal system is particularly important for understanding human behavior because the imagery system has unique theoretical and empirical properties The specific ways in which verbal and nonverbal mechanisms contribute to performance vary with the task, stimulus characteristics, past and present events, and individual differences. Although DCT models emphasize basic mechanisms, the theory also permits and complements explanations cast in terms of such molar processes as strategies and beliefs. Ultimately, the human mind represents and processes strategies in terms of nonstrategy mechanisms, possibly in terms of associative networks of verbal and nonverbal mental representations. With respect to memory for categorized lists of words and related organizational effects, DCT emphasizes the contribution of indirect verbal associations in which multiple words or phrases converge on a shared associate . The shared associate can subsequently act as a retrieval cue for the specific instances that originally elicited it. The mnemonic benefits of schema, scripts and categories, and related organizational effects, are consistent with the DCT associative model. Comparisons favored schematic organizations only when schematically organized lists with labels were compared to category lists without labels. The spatial methods blur the division between imagery and verbal associative processes, and may capitalize on the capacity of the nonverbal system to integrate spatially contiguous events, including verbal labels, in an associative network. (298-301)

**Self-determination theory (SDT)**

Self-determination theory (SDT) is a broad theory of human personality and motivation concerned with how the individual interacts with and depends on the social environment. SDT outlines how intrinsic and extrinsic motivations influence situational responses in social and cognitive development and personality. SDT is centered on the basic psychological needs of autonomy, competence, and relatedness and their necessary role in self-determined motivation, well-being, and growth. SDT describes the critical impact of the social and cultural context in either facilitating or thwarting people's basic psychological needs, perceived sense of self-direction, performance, and well-being. SDT is a metatheory which fuses “mini-theories” together to offer a comprehensive understanding of human motivation and functioning. SDT is based on the fundamental humanistic assumption that individuals naturally and actively orient themselves toward growth and self-organization. People strive to expand and understand themselves by integrating new experiences; cultivating their needs, desires, and interests; and by connecting with others and the outside world. People can become controlled, fragmented, and alienated if their basic psychological needs for autonomy,competence, and relatedness are undermined by a deﬁcient social environment. The individual is involved continuously in a dynamic interaction with the social world – for satisfaction and responding to the conditions of the environment that either support or thwart needs. As a consequence of this person-environment interplay, people become either engaged, curious, connected, and whole, or demotivated, ineffective, and detached.

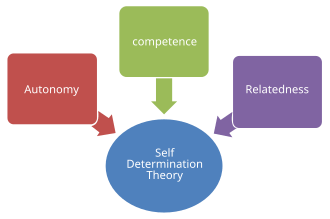
Self-determination theory (SDT) is an empirically derived theory of human motivation and personality in social contexts that differentiates motivation in terms of being autonomous and controlled. Self-determination theory mentions four different sorts of motive (intrinsic, extrinsic, achievement and affiliation) The first of them is intrinsic motivation, which is defined as having an interest in something for oneself and experiencing pleasure and satisfaction from it. The second type of motivation, extrinsic, involves concentrating on achieving particular objectives to receive reinforcements and rewards as well as stay out of trouble. Extrinsic motivation can be divided into four types ranging from least to most autonomous: external (i.e., for reward or praise), introjected (i.e., to avoid guilt or anxiety), identified (i.e., because the person sees value in the activity), and integrated (i.e., because the person has internalized the reasons for engaging in the behavior; The first two are considered Controlled forms of motivation because they place the impetus for action solely with external factors

1. **Externally regulated behaviour**: the most extrinsic but least autonomous form of motivation as it represents motivation due to explicit external control it is performed because of external demand or possible reward. Such actions can be seen to have an externally perceived [locus of control](https://en.wikipedia.org/wiki/Locus_of_control).[https://en.wikipedia.org/wiki/Self-determination\_theory](https://en.wikipedia.org/wiki/Self-determination_theory#cite_note-deCharms,_R._1968-24)
2. **Introjected regulation of behaviour**: describes taking on regulations to behaviour but not fully accepting said regulations as your own.  This is the kind of behaviour where people feel motivated to demonstrate ability to maintain self-worth. While this is internally driven, introjected behavior has an external perceived locus of causality or not coming from one's self. Since the causality of the behavior is perceived as external, the behavior is considered non-self-determined. Introjected motivation is the second-most extrinsic form of motivation, reflecting compulsion, avoidance of guilt or anxiety, and a sense that one “should” or “ought to” complete the behavior. .
3. **Regulation through identification**: a more autonomously driven form of extrinsic motivation. It involves consciously valuing a goal or regulation so that said action is accepted as personally important. Identified motivation describes regulation of behavior for reasons more consistent with one's goals and identity, with individuals seeing the actions as personally important . People acting based on an identified motive do so because they “want” to as opposed to feeling that they “ought” to, as in introjected motivation
4. **Integrated Regulation**: Is the the most internalized and most autonomous kind of extrinsic motivation form. Occurring when regulations are fully assimilated with self so they are included in a person's self-evaluations and beliefs on personal needs. integrated motivations share qualities with intrinsic motivation but are classified as extrinsic because the goals that are trying to be achieved are for reasons extrinsic to the self, rather than the inherent enjoyment or interest in the task. the person values and accepts the reasons for the behavior, though he/she may still not consider it to be inherently fun.

Nonmotivation, which is defined as the absence of either internal or external motivation, is exhibited by people who think they have no control over their conduct. Individuals in this circumstance, imitate learned helplessness, refrain from acting as a result of rewards from inside or outside of themselves.

Achievement motivation refers to an individual’s drive to pursue success in achieving a goal, influenced eşther by personal inclinations or environmental factors.  Affiliation motivation refers to the need to belong with others in relationships while achievement refers to the drive to succed.

Self-determination Theory explains the factors of intrinsic motivation (autonomy, competence, and relatedness) and of extrinsic motivation (internalization and integration) that support personality development and behavioral self-regulation to improve personal wellbeing and performance of people in organizations and society



**Fig.47. the acronym R-I-C-E tthat encapsulate the 4 main motivations.**

* R stands for reward.
* I stands for ideology.
* C stands for coercion.
* E stands for ego.

internal motivation, that is the foundation of self determination, is connected to intrinsic motivation, which enables people to engage in any activity since doing so would satisfy their interests rather than their desire to be met externally. rewards or reinforcements received from outside sources have a negative effect on one's own drive. needs are internal psychological nutrients required for psychological growth, integration, and well-being. meeting people's psychological needs raises well-being while avoiding needs reduces it, similar to how a plant grows and develops when watered and withers when care is neglected. Persons have three distinct psychological needs, all of which are innate, essential, and universal. Individuals must have their fundamental needs of competence, autonomy, and relatedness addressed in order to maintain their sense of completeness, wellbeing, and "education" over the course of their lives. The three basic psychological needs have been validated.The need for autonomy from basic psychological needs; is the requirement for an individual to behave in accordance with his or her own sentiments and wishes, to participate in actions that are compatible with those choices, and to freely regulate those behaviors By meeting their desire for autonomy, people who take responsibility for their own choices, accept the results of their choices, and feel in control of their own behavior contribute to their subjective well-being . Relatedness is described as the desire to engage in meaningful relationships with others, to feel connected to the social environment, to belong, and to develop interpersonal ties. Relatedness involves the sensation of closeness and connecting with others. People need to engage in shared activities, feel as though they have a meaningful role in the lives of others, be understood and valued by others, and have friends with whom they can connect in order to satiate their need for relatedness. This helps people avoid being isolated from others due to introverted and insecure sentiments . Competence is the requirement to have a good impact on the environment and to deal with it effectively and efficiently. It is the culmination of a person's education, interactions with their surroundings, and environmental adaption. people with their competence can deal with issues by relying on their own knowledge and skills in new situations, people with unmet competence needs use their knowledge and skills ineffectively and are unable to deal with the situation . Satisfaction, that increases intrinsic motivation, is closely related to individuals' well-being. it is expected that the person who is given autonomy support and has a high sense of efficacy will have a strong internal motivation, which will help the person to be more in charge of his life. the need for relatedness is an important resource in maintaining intrinsic motivation, but does not influence intrinsic motivation as much as autonomy and competence. Meeting the three fundamental needs is crucial to self-determination theory. meeting only one of the needs of individuals and neglecting or preventing the other will negatively affect their well-being. as in the attitudes of parents who want their children to give up their autonomy to meet their relational needs, meeting one need is conditional on giving up another need creates a ground that may cause alienation or pathology. (302-305)

**Addiction**

Addiction affects each of the family member in one way or the other. In an addictive family system, the disease becomes the sorting principle. When you love someone who is into substance addiction, it creates a penetrating emotional pain and agony that compels one to help. Their behavior begins knowingly or unknowingly as a well intentioned need to help, but in later stages of addiction they end up acting out of distress. The other family members often tend to over function and the substance abuser tend to underfunction, thus skewing the family dynamics. Resentfulness is formed on each side uplifting the expectations of drug user that the loved one who already overfunctions will continue to support, protect, nurture and still make things right even when one doesn’t meet their responsibilities. Stopping such behavior isn’t easy. It requires great amount of faith and courage to weigh down the sequel and to work against their behavior creating anguish on both sides. The pressure for codependents can be intense, specific gainst their behavior creating anguish on both sides, specifically those coming from angry addicts who generally influence the family members to get their unsaid and self understood needs met. Substance abusers aren’t aware of their actions when they are under the effect of substance. The family members often experience anger, fear, guilt, grief and isolation due to the presence of an substance abuser in the family. When loved ones develop the wisdom and therefore the courage to prevent the codependent behavior for addicts, changes start to happen. (306)

**Codependence**

The spouses who had poor social support, less coping resources and had less impairment in employment had increased chances of developing codependence . The non substance abusing family members often experience family dysfunction . Codependents usually sacrifice themselves to accommodate for other’s needs, solve other’s problems and assume more than their share of responsibility at handling chores and relationships. Codependent individual is unable to foresee the natural consequences their behavior towards the substance dependent individual. Codependents feel compelled to solve other people’s problems. Their behavior starts as a well intentioned desire to help but in later stages of substance abusing they act out of disheartenment. Having a family member with substance use problems affects the entire family dynamics, which lead to increased medical problems and increased health care utilization and expenses in the family members. The codependent behaviors seem to unravel the issues of substance dependence in order that the addict is under lesser stress decreasing their motive to abuse. Though their intensions are good but they find themselves being destructive. Engaged coping is a sort of coping during which the spouses of substance abusers gets vigorously engaged with their husband through active intervention. They tend to use various emotional, helping and controlling behaviors to vary his/her addiction habit. Coping behavior or enabling behavior described among spouses of substance abusers include refraining, coddling and fearful withdrawal. In initial years they begin with tolerant styles, in a hope to get things better but ultimately their efforts go in vain as they unknowingly hinder the pathway of recovery for the substance abuser .

Codependency causes many behavioral disorders and psychiatric diseases such as stress, anxiety, and depression. It is also considered as a community mental health problem because it is learned and transferred in the family. Since individuals with a chronic mental illness need long-term family support, it is important to evaluate caregivers in terms of codependency. Codependecy is a behavior pattern that poses a major obstacle to individuals' capacity to create and sustain functional relationships, as a pattern of dependency that includes compelling behaviors against approval and acceptance from others in search of trust, self-worth, and identity in mutual relationships. As a pattern of dependency that includes people's compulsive behaviors towards approval and acceptance from others, it poses a great obstacle for individuals to establish and maintain functional relationships .

Attachment style affects the characteristics of the partner we choose in our life, and the way the relationship is lived and how we perceive our life, and ourselves. Whether the needs are met or unmet in the relationship with the mother, who is the first object, determine what the person seeks and tries to satisfy throughout his life. Attachment theory was pioneered by psychologist and psychiatrist John Bowlby, who discovered that mothers of neurotic children tend to replace hostility originally related to their own parents. They also tend to place excessive and unreasonable demands on them in an effort to fulfill unfulfilled affectionate needs. Attachment theory is a child psychoanalysis . Child develops the fastest physically, mentally, and emotionally, between the ages of 0-2, which is defined as the infancy period. Indispensably, the baby will be dependent on the person who cares for him/her since his skills are not yet sufficiently developed. The term attachment indicates to the existence of an emotional and helpful relationship between infants and their caregivers . In this period, the first person that the new-born applies to meet his/her social needs is the person who looks after him/her, which is usually the mother. The mother can also be referred to an "other" to whom the child's need for attachment is satisfied. Besides, others can be added to a hierarchy, a baby can have a primary attachment to his/her mother, and then his/her father, siblings, and grandparents can come. If there is no mother, or if there is someone else with whom he/she has a more intimate relationship, that person would be the primary attached person. The mother image formed around the age of three creates a platform to understand not only ourselves but also all the "others" we encounter in the rest of our life.

Children who are securely attached rely on those people and feel safe as a result. Even though they could be upset when the associated adult departs the setting, they are confident in the adult's return. When children are safely bonded, they turn to their attached adult for comfort. These children are aware that the person to whom they are attached is always there to provide support, safety, and care. Babies whose needs are consistently met have developed a secure attachment and do not show overly anxious reactions in their mother's absence and calmly wait for their mother's return. When their mother returns, they continue their behavior and do not show any negative reaction. They tend to perceive their mother as a safe base while exploring. In the presence of the mother, they explore the environment along with visual, verbal and physical interaction. As the mother leaves the environment, her discoveries decrease. They may react to cry or not cry, but when their mother or caregiver returns, they make a very positive welcome. If their sadness is high, they approach their caregivers to relax and continue to explore . Secure attachment is a concept that is positively related to psychological well-being and emotional health, with mental health indicators such as self-confidence and resilience and shows positive relationships with understanding emotions, social problem-solving skills, conscience development, and positive self-concepts. Primary caregivers ofsecurely attached children play more games with children, respond rapidly to children's needs, and are more sensitive to their children than insecurely attached children

When children with anxious-ambivalent attachments are taken away from their mothers, they become incredibly restless and exhibit stress symptoms. These unfavorable sensations do not go away when the person they are linked to leaves the room, and they find it difficult to calm down. These children are quite wary of strangers. Children with this attachment pattern typically have an unstable primary caregiver who struggles to satisfy their needs. Even when children can occasionally reach the adult, there are instances when the caretaker is too preoccupied to watch after the child. Infants whose needs are inconsistently met in a timely manner develop an anxious/ambivalent attachment style. In the absence of their mother, they show extremely anxious reactions and display these reactions until the mother returns. When the mother returns, the baby does not relax and shows angry reactions toward the mother. They may not even want their favorite toys . On one hand, they try to establish intimacy because they want their mother to calm them down, but on the other hand, they do not want to establish complete intimacy. They may be friendlier to a stranger than to their mother. Anxious-ambivalently attached children may become overly dependent on others in later life and they are hesitant to approach others as adults even when their sentiments are not shared. Due to the frigid and distant nature of the connection, these people frequently face separations in their love relationships .

Children that avoidant attachment has a propensity to disregard the caregiver. They do not express a preference when given the option to pick between a caregiver and a stranger. When the adult leaves the room and comes back, the avoidant attached children pay the caregiver no attention and do not require the person they are attached to, to give a recommendation or make a contact with. Instead of experiencing rejection, avoidant children seek tight relationships. Caretakers may neglect them (emotionally, physically, etc.), or have their needs disregarded, which go beyond basic bodily requirements to include emotional contact for forming connections and social interaction requirements. Babies with an insensitive attitude toward their needs form an avoidant attachment style. They behave independently of their mothers while exploring their surroundings. These babies do not show any positive or negative reaction when their mother leaves the room. When the mother returns to the room, this unresponsiveness continues, and they do not seek any intimacy or try to establish physical contact ort feel the need to relax. Although they want to be close, they act as if they have no connection with their mother because they think they will be rejected. Since they think that they are resistant to the reactions of the caregiver and punish them, they avoid asking for help and support in their later ages. The concept of codependency was first used in the 1940s to describe the behavior patterns of individuals living with or having relationships with people with addictions in the United States. Experts have began to see situations where the spouses of alcoholics or drug addicts are also dependent on them. Based on observations, they argued that such behavior contributes to their partner's addiction, and even when the person with alcohol addiction has recovered from the addiction, codependents still maintain their co-dependency in the same way.

The family environment of people, their relationship with parents, and whether there is someone living with addiction in their home were found the causes of codependency . Over time, the definition of codependency has included people who have relationships with chronic patients, parents of children with behavioral problems, irresponsible individuals, professionals, nurses, social workers, and other professionals in helping positions.An essential characteristic of codependent people is that they keep placing their selfworth in their capacity to command and shape other people's actions and emotions. A codependent constantly meets the wants of their significant other in an effort to regulate their feelings. They think that person is required to provide the codependent with the love they desire. Rather being rewarded by affection, codependent actions are frequently ignored or resented, that causes emotions of inadequacy, a sense of having acted incorrectly, and a sense of needing to do more. Codependents employ a variety of defense mechanisms, including denial, rationalization, and projection, to deal with such distressing circumstances.

Codependents are typically described as giving their all to their spouse and gratifying all he/she needs. They mask their genuine feelings, to comprehend and meet their own needs Codependents tend to have strong desires for approbation but also a lot of self-doubts and a sense of having poor interpersonal control. They are reluctant to speak well of themselves . These people typically struggle with poor self-esteem and codependency worry about being abandoned, that they find intolerable and they are constantly reminded by a persistent inner voice that "If you are needed by other people, you won't ever be abandoned." The first cause of codependency,is having an alcoholic spouse or living with an alcoholic at home or growing up in a stressful family environment in which they establish dysfunctional relationships and show self-sacrificing behaviors Children who grow up in families with authoritarian and oppressive attitudes have personality traits that are submissive to others, cowardly, and make great effortsto fulfill what is asked of them .

In the relationship between mother and baby, difficulties arise in adjusting the correct distance due to the mother's suffocating protection of her child or the fact that there is very little presence decently in the child's life. The mother, who does not allow the perception of deficiency to be formed by seeing the needs in advance, inhibits the child's demand. Thus, the child cannot develop an individuality of his/her own. Having an identity whose autonomy is not sufficiently developed can be interpreted as a risk factor for the development of codependency .Being codependent in relationships may have a detrimental effect on a person's life even if codependency is not recognized as an official mental health diagnosis. A codependent person neglects his/her own needs in favor of being too concerned with satisfying those of another person, whon then becomes the center of their universe. As a result, both parties experience one-sided unhealthy and dysfunctional relationship . While dependent personality disorder depicts dependence on others , codependency is a dependence on a single individual.

Codependent actions is not always displayed by people with dependent personality disorder. According to attachment research, characteristics of codependents are nervous, insecure, and avoidant of intimate relationships. Codependents appear to have a strong need for reciprocation and merger in a relationship but also dread closeness. No one, in their opinion, is as eager to make a commitment as they are. They are obsessed with the people they are in relationships. They claim to have a strong physical attraction to their relationships and to be fiercely possessive and jealous of their partner’s attention. They lack confidence in their capacity to rely on another person for protection, fear being abandoned, trouble trusting, feeling misunderstood, and doubt their own deserving of love and have stressful relationships.Codependents feel emotional empathy for their spouses, but they are not inclined to show support or care and reveal more sentiments of rivalry in their partnerships and exhibit less secure attachment patterns and lower levels of different satisfaction measures, as well as anxious and avoidant attachment styles, social anxiety, and public self-consciousness, they have a strong yearning for a deep connection but significant doubts about their ability to attain .

Individuals who are securely attached in childhood feel valued in their adulthood, they find other people acceptable and lovable. An anxious attachment style is an individual who has low self-confidence, perceives others as supportive but does not benefit, and cannot reveal their own feelings and thoughts. Avoidant attachment style finds himself/herself valuable and lovable, but they tend to stay away from disappointment and close relationships .The exchanges between the self and the selfobject called transferences. The need for mirroring refers to the first of these transferences. The baby expects a response with his/her expressions and behaviors towards the mother. Expects a laugh, a nod of approval, or a "well done" in return. While doing this, the infant takes a pompous attitude to highlight how great his/her performance is. He or she wants to be recognized for their achievements. The infant and selfobject are interacting for the first time in this manner. The infant feels seen and confined as a result of the selfobject's appreciation for him or her. He or she feels like a beloved, revered, and respected being. This requirement and the development of this behavior signify the start of investment in the object. When the infant is not admired by the object, narcissism is present as a state that prompts behavior and contributes to health and well-being and results in sickness If unmet,.

The construct of co-dependency evolved from the chemical dependency field in the treatment of families of alcoholics. This term has become popular among mental health professionals as well as the general public since its inception at the end 1970s. Other problems, such as overeating and gambling, paralleled the illness of alcoholism, could affect family members in a similar fashion. A co-dependent person has become one who has a relationship, personally or professionally, with a "troubled, needy, or dependent person.To be labelled co-dependent is increasingly to be judged as sick. Co-dependents have been described as having a “lost self.” “a loss of one’s inner reality and an addiction to outer reality.” “as a person who can’t function from his or her innate self and instead organizes thinking and behavior around a substance, process, or relationship. Co-dependents become dependent on other people in unhealthy ways, even though they might do fine on their own. The degree of co-dependency varies on a spectrum. Co-dependency is a disease and addiction because, the behaviour is compulsive and worsens over time if untreated. It progresses through stages of degeneration and regeneration during its decline and recovery In addition to parental chemical dependency, other family stressors may include ineffective parenting styles, parental abuse, as well as parental mental and physical health, maternal coercion to be significant predictors of co-dependency. The co-dependency occur not only in the families of drug addicts, alcoholics, abuse problems but in those who have been physically or sexually abused. The family patterns of thinking and behaviour are unconsciously copied by the child and he or she uses them later on in adult relationships in the same form or in a different one. what we see as the actions of our parents when we are children ( our mother or father having a problem with boundaries, and had unhealthy ways to communicate) we learned these behaviours and brought them into our intimate relationships. Children who grow up with emotionally unavailable parents also are at risk for being co-dependent. They often find themselves in relationships where their partner is emotionally unavailable, yet they stay in the hopes that they can change the person.

happens, they won’t stop hoping that one day things will be good. [3

The list of symptoms of co-dependency and being in a co-dependent

Relationship:

Low self-esteem (the person feels that he/she is not good enough or comparing himself/herself to others; what such persons actually feel is that he is unlovable or inadequate; feelings of shame and guilt and perfectionism go along with low self-esteem) . People-pleasing (co-dependents usually don’t think they have a choice. Saying “No” causes them anxiety. co-dependents have a hard time saying “No” toanyone, they go out of their way and sacrifice their own needs to accommodate other people)

Poor boundaries.( They have blurry or weak boundaries. if someone else has a problem, they want to help them to the point that they give up themselves)

other people’s feelings and problems or blame their own on someone else.)

 Reactivity.(A consequence of poor boundaries is that react to everyone’s thoughts and feelings. )

Control.(Control helps co-dependents feel safe and secure. Everyone needs some control over events in their life. For co-dependents, control limits their ability to take risks and share their feelings communicating their thoughts, feelings and needs, spend their time thinking about other people or relationships

Dysfunctional communication.

Obsessions (Due to their anxieties and fear, co-dependents have a tendency to Dependency (Co-dependents need other people to like them to feel okay

Denial. they’re in denial about not only about facing their problem, but also about their feelings and needs.

Problems with intimacy.(they often experience sexual dysfunction and find it very difficult to be open and close with someone in an intimate relationship. )

Painful emotions.(Co-depends experience stress and painful and complex emotions: shame and low self-esteem, fear about being judged, rejected or abandoned; feeling trapped by being close or being alone, anger and resentment, depression, hopelessness, and despair. )

other person(s).” [2] The disorder exists in the person whether or not he or she is in a



the primary caretaker is the mother; it may be the father, grandparent, or other relative orcombination of people. When infant parenting is inadequate, it reflects dysfunction in the whole family, which further damages the growing Their partner or they themselves may be workaholics or develop some other compulsive behaviour to avoid the feeling of emptiness in the relationship.

The following steps are suggested for healing co-dependency in intimate relationships

1. Getting Help for love addiction in a toxic relationship

2. Combat Co-dependency with Independence

If the person is struggling with shifting their focus to the themselves, a great way to achieve this is by finding areas in being independent are: joining a fitness class or interest group, ensuring to have at least one night with friends a week or picking up a hobby that the person had left behind due to the relationship.

the person’s life where the person can be independent from the partner. Some examples of

3. Be Prepared for Relationship Withdrawal

As with any addiction, if the person are addicted to a relationship, the person will experience withdrawal when the person decide to stop it. Co-dependency is an emotional and behavioural issue that causes a person to be incapable of having a mutually satisfying, healthy relationship. A co-dependent partner will stick by their partner suffering from addiction no matter how unhealthy the relationship is.

Relationships can be one of the major triggers in a person’s addiction and they may

to get into a new relationship. It’s important to understand unhealthy relationships, co-

Codependency means not being able to say no , being influenced by the behaviour of another person and obsessed with changing the behaviour of the other person. Codependent individuals hold themselves responsible for various situations such as the thoughts, feelings, and needs of other people. Definitions of codependency have four main characteristics called external focus, self-sacrifice, controlling others, and suppressing individual feelings. In unhealthy relationships, the balance of receiving and giving is not equal. Such relationships where personal boundaries are not clear are defined as codependency. Codependent people have difficulties in taking care of themselves, neglect themselves while focusing on others and forget their own needs and feelings. They try to solve the problems of others and meet others’ needs so that they themselves can feel good . Codependent people may experience various problems because they ignore their own needs and constantly try to solve other people's problems. They have depressive feelings because they are not always able to please others. One of the characteristics seen in codependent people is low self-esteem as the people’s positive/ negative attitude to himself/herself. Selfesteem has four components: self-confidence, self-love, self-efficacy and the way one sees oneself Self-love is the basis of self-esteem . codependent people want to be loved by others but they think that they are not worthy of being loved. These people seem to try to please others rather than themselves. codependent people feel different from other people, fear rejection, find their own lives worthless, feel ashamed of being themselves, and feel hurt when they do not receive appreciation. Co-dependency is a psychological concept that describes an unhealthy relationship that individuals may have with those who are closest to them. A codependent relationship is one in which one partner takes on the role of "the giver," putting aside their wants and happiness in favor of the other, who is "the taker." Excessive emotional or psychological reliance on a spouse, usually one who needs help due to an addiction or sickness. In a codependent relationship, one person is dependent on the other. there may be biological, psychological, and social elements that contribute to codependency

Early stage: Codependents become increasingly and unhealthily obsessed with someone. Problematic behavior is denied or rationalized. Lost in their desire to please, the codependent may give up their friends and activities.

Middle stage: Self-blame, guilt, and anxiety rise. As the codependent invests increasingly more in the relationship but receives little in return, their self-esteem rapidly declines—disappointment, bitterness, and frustration increase. The codependent could nag, blame, or manipulate their loved one to make them change. They could exaggerate to family and friends about the actions of their loved ones and participate in addictive behaviors including substance a abuse, binge drinking, unhealthy eating, gambling, or excessive shopping rises. the codependent also exhibits an increase in cooperative, dependent, and compulsive tendencies.

Late stage: Co-dependency signs have an impact on both mental and physical health. Stress-related conditions include heart disease, sleeplessness, sciatica, headaches, muscle pain, digestive issues, and eating disorders may manifest. Addiction makes things worse. Self-care is no longer important as self-esteem plummets.

The main sign of codependency is consistently elevating the needs of others above your own. This may manifest as self-sacrifice, seeking approval from others, or accepting blame to avoid conflict.Other signs include controlling behaviors, self-sacrifice, and fear of rejection. Codependency is a way of behaving in relationships where you persistently prioritize someone else over you, and you assess your mood based on how they behave.

[Codependent traits](https://psychcentral.com/health/what-is-codependency-traits/) can eventually:

* lead to a disconnect from your own needs and desires
* promote unhealthy relationship dynamics
* affect self-worth and overall well-being

“Codependency refers to any [enmeshed relationship](https://psychcentral.com/blog/imperfect/2019/05/the-enmeshed-family-system-what-it-is-and-how-to-break-free) in which people loses their sense of independence and believes they need to tend to someone else,”  patterns of codependent behavior involve four main themes:

1. self-sacrifice
2. a tendency to focus on others
3. a need for control, which may fuel conflict
4. difficulty recognizing and [expressing emotions](https://psychcentral.com/health/inventive-ways-to-identify-and-process-your-emotions)

Common signs of codependency include:

* a deep-seated need for approval from others
* self-worth that depends on what others think about you
* a habit of taking on more work than you can realistically handle, both to earn praise or to lighten a loved one’s burden
* a tendency to apologize or take on blame in order to keep the peace
* a pattern of avoiding conflict
* a tendency to minimize or ignore your own desires
* excessive concern about a loved one’s habits or behaviors
* a habit of making decisions for others or trying to “manage” loved ones
* a mood that reflects how others feel rather than your own emotions
* [guilt](https://psychcentral.com/blog/5-tips-for-dealing-with-guilt#1) or anxiety when doing something for yourself
* doing things you don’t really want to do simply to make others happy
* idealizing partners or other loved ones, often to the point of maintaining relationships that leave you unfulfilled
* overwhelming [fears of rejection](https://psychcentral.com/lib/good-news-if-you-often-feel-rejected) or abandonment

**Codependency vs. dependency**

Healthy dependence means you state your own needs and desires, ask for support when you find yourself struggling, feel safe and comfortable expressing your own needs and let others know when they are asking too much of you withoutn worrying they’ll reject you. shows up in romantic relationships. Codependency, known as relationship addiction, takes place when one person believes it’s their job to “save” another person by attending to all of their needs. A codependent person builds their identity around this purpose and takes on a self-sacrificial role in the relationship.Codependency is used to describe a person who enables their partner’s addiction by covering up their problems or shielding them from the consequences of their behavior For example, if you’re codependent, you might take on excessive household responsibilities, fail to stand up for yourself, or end other friendships just to maintain your partner’s approval. This unhealthy dynamic isn’t limited to romantic relationships. You can have a codependent relationship with a family member or friend. A codependent relationship has the potential to become one-sided or destructive.You might feel frustrated, resentful, or stressed out as you neglect your own needs and prioritize your partner’s.You might even find yourself tolerating physical, sexual, or emotional [abuse](https://www.helpguide.org/relationships/domestic-abuse/domestic-violence-and-abuse). And when a relationship fails or goes through a rough patch, you may experience a loss of self-worth because your identity is so tied to your partner.Your partner, on the other hand, might not seek help for issues you enable, such as substance abuse, [gambling addiction](https://www.helpguide.org/mental-health/addiction/gambling-addiction-and-problem-gambling), or an [eating disorder](https://www.helpguide.org/mental-health/eating-disorders). a partner might label you as “clingy” or lash out at your attempts to control them. people with codependent tendencies have hard time maintaining healthy, satisfying relationships.

**Signs of codependency**

Lack of satisfaction or purpose in life outside of the relationship. Your sense of identity is wrapped up in your partner’s, friend’s, or family member’s, so it’s difficult to maintain relationships or enjoy hobbies independently.

Tendency to endure a partner’s harmful behavior.  When friends speak out about your partner’s abusive behavior, you defend them or shift the blame to yourself.

Idealization of partner if you’re codependent, you might put your loved one on a pedestal or fail to acknowledge the flaws that everyone has.

Enabling partner’s poor choices and behavior. If your partner [has an addiction](https://www.helpguide.org/mental-health/addiction), you might lie to other people about it, make excuses for your partner’s behavior, or bail them out of trouble. While rooted in good intentions, this prevents your loved one from facing the consequences of their actions and learning from their mistakes.

Controlling behavior. You might try to manipulate your partner into doing what you want, failing to realize the only person you can ever control is yourself. You might mistakenly believe that controlling the other person will somehow lead you to happiness.

Guilt when not attending to your partner’s needs and wants. You see it as your job to “fix” all of the other person’s problems. So, you experience guilt when you take time to focus on yourself or anything outside of the relationship.

Unwillingness to state needs, desires, and moral stances due to fear of conflict You might feel alone or neglected in the relationship but keep it to yourself because you don’t want to potentially upset your significant other. You might also stay silent when the other person does things you morally oppose, such as [bullying](https://www.helpguide.org/family/parenting/bullying).

Taking on undue blame. Rather than run the risk of an argument, you might just go along with whatever the other person in the relationship says

Taking on too much responsibility.

Preoccupation with the other person’s thoughts or feelings. You might obsess over whether your partner is upset . Your mood might reflect your perception of their mood, since you disregard your own emotions.

Table.4.Codependent relationship vs. interdependent relationship

| Codependent relationship | Interdependent relationship |
| --- | --- |
| The codependent person has no hobbies and only does what their partner does. | Each person maintains separate hobbies while also having shared interests together. |
| The codependent partner always does the household chores and takes the blame if they’re not completed. | Both partners look for ways to contribute to the household. |
| The codependent person keeps their partner’s gambling addiction a secret and pays off their debts. | Each partner encourages the other to address problems, such as addiction, without enabling the behavior. |

Relationship addiction can be traced back to past experiences. Past family dynamics have a lasting effect on all of us, even if those effects go unnoticed. the relationship you had with your parent or caregiver during infancy can influence your behavior as an adult. You might be able to tie your codependent habits back to your [family dynamics](https://www.helpguide.org/relationships/social-connection/dealing-with-difficult-family-relationships). Certain household dynamics negatively affect emotional development. The  [attachment style](https://www.helpguide.org/relationships/social-connection/attachment-and-adult-relationships#different) is shaped by the connection established as an infant with the primary caregiver. An insecure attachment can set up for codependency issues later in life. If the parent or caregiver tended to fluctuate between being responsive to your needs and being unavailable, you might have developed a sense of insecurity around relationships. This is known as an [ambivalent (or anxious-preoccupied) attachment style](https://www.helpguide.org/relationships/social-connection/attachment-and-adult-relationships#ambivalent-anxious).

People with this attachment style tend to:

* Desire closeness but feel anxious about their partner’s reliability.
* Become fixated on another person.
* Overreact to perceived threats to the relationship.
* Crave lots of attention from their partner in order to feel reassured.
* Have a hard time maintaining boundaries because they feel anxious when away from their partner.

People with this insecure attachment style try to ease their anxiety by tending to their partner’s every need and constantly seeking approval. They may also seek to control their partner via manipulative tactics. Ambivalent attachment, which is a type of insecure attachment style formed during infancy, can have a negative effect on your relationships as an adult. The brain is capable of change at any age and steps to develop a secure attachment style by

Strengthening your nonverbal communication skills.

Increasing your emotional intelligence

Addressing childhood trauma.

Seeking relationships with people who have secure attachment styles

Low self-esteem, can lead to codependent habits. If you feel as if you’re unworthy of love, you might go to gain approval or to feel wanted. For example, you might take on a caretaker role and put too much focus on the needs of others.

Some codependent people report difficulty developing a sense of self. Instead, they modify themselves to feel liked and accepted by those around them. That feeling of acceptance builds their self-esteem but at the cost of a stable sense of self. For example, they may say they like movies, music, or hobbies that their friends like, just to feel accepted.

In a codependent relationship, both people can fall into behavioral patterns that reinforce a one-sided dynamic. Essentially, one person is always being selfless, while the other grows accustomed to being coddled. It’s possible to adjust this dynamic by changing your codependent behavior. The road to a more independent lifestyle involves:

* Knowing the difference between controlling and supporting your partner.
* Separating your interests and goals from those of your partner.
* Focusing on and asserting your needs.
* Identifying and challenging negative thoughts.
* Building your self-esteem.

In [healthy relationships](https://www.helpguide.org/relationships/social-connection/relationship-help), two people support each other.

Denial Patterns

* Have difficulty identifying what they are feeling
* Minimize, alter, or deny how they truly feel.
* Perceive themselves as completely unselfish and dedicated to the well- being of others
* Lack empathy for the feelings and needs of others.
* Label others with their negative traits.
* Think they can take care of themselves without any help from others.
* Mask pain in various ways such as anger, humor, or isolation.
* Express negativity or aggression in indirect and passive ways.
* Do not recognize the unavailability of those people to whom they are attracted.

Low Self-esteem Patterns

* Have difficulty making decisions.
* Judge what they think, say, or do harshly, as never good enough.
* Are embarrassed to receive recognition, praise, or gifts.
* Value others’ approval of their thinking, feelings, and behavior over their own.
* Do not perceive themselves as lovable or worthwhile persons.
* Seek recognition and praise to overcome feeling less than.
* Have difficulty admitting a mistake.
* Need to appear to be right in the eyes of others and may even lie to look good.
* Are unable to identify or ask for what they need and want.
* Perceive themselves as superior to others.
* Look to others to provide their sense of safety.
* Have difficulty getting started, meeting deadlines, and completing projects.
* Have trouble setting healthy priorities and boundaries.

Compliance Patterns

* Are extremely loyal, remaining in harmful situations too long.
* Compromise their own values and integrity to avoid rejection or anger.
* Put aside their own interests in order to do what others want.
* Are hypervigilant regarding the feelings of others and take on those feelings.
* Are afraid to express their beliefs, opinions, and feelings when they differ from those of others.
* Accept sexual attention when they want love.
* Make decisions without regard to the consequences.
* Give up their truth to gain the approval of others or to avoid change.

Control Patterns

* Believe people are incapable of taking care of themselves.
* Attempt to convince others what to think, do, or feel.
* Freely offer advice and direction without being asked.
* Become resentful when others decline their help or reject their advice.
* Lavish gifts and favors on those they want to influence.
* Use sexual attention to gain approval and acceptance.
* Have to feel needed in order to have a relationship with others.
* Demand that their needs be met by others.
* Use charm and charisma to convince others of their capacity to be caring and compassionate.
* Use blame and shame to exploit others emotionally.
* Refuse to cooperate, compromise, or negotiate.
* Adopt an attitude of indifference, helplessness, authority, or rage to manipulate outcomes.
* Use recovery jargon in an attempt to control the behavior of others.
* Pretend to agree with others to get what they want.

Avoidance Patterns

* Act in ways that invite others to reject, shame, or express anger toward them.
* Judge harshly what others think, say, or do.
* Avoid emotional, physical, or sexual intimacy as a way to maintain distance.
* Allow addictions to people, places, and things to distract them from achieving intimacy in relationships.
* Use indirect or evasive communication to avoid conflict or confrontation.
* Diminish their capacity to have healthy relationships by declining to use the tools of recovery.
* Suppress their feelings or needs to avoid feeling vulnerable.
* Pull people toward them, but when others get close, push them away.
* Refuse to give up their self-will to avoid surrendering to a power greater than themselves.
* Believe displays of emotion are a sign of weakness.
* Withhold expressions of appreciation.

Healthy relationships require a specific balance of both independence and dependence — each person in the relationship has their own identity and autonomy (independence) while feeling appropriately connected to another person for support and care (dependence). interdependency is a healthy, balanced way of relating to and connecting with others in relationships. an interdependency relationship allows for intimacy, support, and connection while still maintaining a sense of autonomy and individuality for each person involved. key characteristics of interdependency include:

Clear boundaries: All parties have a strong sense of self and respect each other's boundaries, needs, and autonomy.

Mutual support: Each person supports one another’s growth and well-being, without sacrificing their own needs or losing their sense of individuality.

Emotional intimacy: There is a deep emotional connection, but each person also maintains their own identities and interests outside of the relationship

Balance of power: The relationship is based on equality, with each person contributing and having an equal say in decisions that affect them.

Healthy dependence: Each person can depend on the other for emotional support, companionship, and practical assistance when needed — but this dependence is balanced and not excessive

codependency can be thought of as an imbalanced, dysfunctional way of relating that diminishes individuality. Interdependency, on the other hand, nurtures both togetherness and independence in a balanced, mutually supportive way. The difference in self identiity and autonomy,reciprocity,balance of power and control are as follows:

Codependency involves

poor or nonexistent boundaries, with an unhealthy enmeshment between each person.

one's sense of self-worth and identity becomes reliant on the other person's approval or needs.

leads to excessive caretaking, enabling, and sacrifice of oneself for the other attempts to control or manipulate the other's behaviors and feelings

Interdependency:

Maintains clear, healthy boundaries that allow for individual identities and autonomy.

fosters a strong, separate sense of self for each person.

involves mutual, healthy support without destructive over-involvement or neglect of self Interdependent relationships respect each person's autonomy without coercion

Since the dynamic relies on enmeshment and extreme closeness, people interpret signs of codependency can be interpreted as deep connection and love. The feelings that approve the codependency may be listed as follows:

Intense fear of abandonment with experiencing anxiety, panic, or distress at the thought or reality of your person leaving you or ending the relationship

Jealousy and possessiveness when the other person gives attention to others or becomes overly possessive of their time

Difficulty identifying your own feelings: confused about what you're truly feeling versus simply mirroring your person's emotions

Mood dependency: if your emotional state primarily hinge on whether your person is happy, approving, or meeting your needs

Denial of feelings: tending to repress, deny, or minimize your own emotional experiences, especially when they conflict

While interdependent relationships rely on solid boundaries, codependent relationships rely on just the opposite: a lack of boundaries. Boundaries help us cultivate autonomy and can prevent us from feeling taken advantage of or disrespected.

The following questions may show if the relationship is codependent:

İf you have difficulty making decisions or taking actions without excessively relying on another person's input or approval

Have you abandoned hobbies, friendships, or activities you previously enjoyed to devote more time to another person

Do you struggle to express diverging opinions or decline requests from another person, even when you want to

Do you frequently prioritize another person's needs over your own wants and routinely sacrifice your own self-care

Are you and another person overly involved in each other's personal responsibilities like work, finances, or relationships with others

Codependents have good intentions regarding their role in the relationship: They want to help and support their loved ones as much as possible. But without reciprocity, these good intentions can be taken advantage of and end up enabling another person's poor behavior.

Codependents in a relationship occupy one of these “giver” roles or a mix of all three:

* 1. Caretaker: You frequently put another person's needs before your own, even sacrificing your own well-being. giving substantially more effort, energy and compromise than you receive in return from the other person.
  2. Rescuer: You find yourself constantly "rescuing" another person from their problems, responsibilities, or consequences instead of allowing them to take accountability. This might look like controlling or trying to “fix” the other person instead of accepting them as they are.
  3. Enabler: You often make excuses, minimizing or covering up for the other person's unhealthy behaviors instead of establishing boundaries.

For every “giver,” there’s usually a “taker.” A “taker” is typically the other person in the relationship who takes advantage of the “giver” either knowingly or unknowingly. In this way, the “taker” gives the “giver” a sense of purpose, and the “taker” gets their needs met leading to an unhealthy pattern of relating to one another. Codependents often experience:

Difficulty expressing needs: struggle to openly and directly communicate your wants, needs, and boundaries to the other person

Criticism/blame: communication is frequently laden with criticism, blame, and finger-pointing rather than taking responsibility for your own feelings.  
Passive-aggression: You or the other person tend to express anger, frustration, or disagreement through indirect means like sulking, avoidance, or sarcasm

Walking on eggshells: find yourself censoring your true thoughts and feelings out of fear of upsetting the other person.

Frequent apologiesYou constantly feel the need to apologize, even when you've done nothing wrong.

Low self-esteem in a codependent relationship include:

Deriving self-worth from another person: You base your sense of self-worth primarily on the other person's feelings towards you and their approval

Feeling not enough: thought of being without the other person fills you with a sense that you couldn't cope or wouldn't have value alone

Lacking self-trust: frequently second-guess yourself or depend excessively on your person to make decisions, even about your own life.

Hearing a loud inner critic : hyper-critical of yourself, constantly putting yourself down or ruminating over perceived flaws and mistakes.

Staying in unhealthy situations remain in situations or tolerate treatment from your person that you know is unhealthy or detrimental because you don't feel deserving of better. (307-308)

**Acceptance and Commitment Therapy (ACT)**

Acceptance and Commitment Therapy (ACT) is a transdiagnostic form of behavior therapy that incorporates mindfulness, acceptance, and behavior-change strategies to help individuals achieve behavioral goals in accordance with their personal values. ACT employs a number of methods and processes to increase psychological flexibility, which may be defined as the ability to openly encounter whatever thoughts, emotions, physical sensations, or urges are present in a given situation while persisting with or changing behavior according to personal values. Exposure can be used to facilitate psychological flexibility within the ACT model. This method consists of assisting an individual to approach and engage with anxiety-producing stimuli in objectively safe situations, without engaging in escape or avoidance behaviors (i.e., “coping” or “safety” behaviors). Acceptance and cognitive defusion appear to facilitate exposure outcomes , especially for individuals who have multiple problems , or high levels of avoidance behavior . From an ACT perspective, exposure may be conceptualized as the “organized presentation of previously repertoire-narrowing stimuli in a context designed to ensure repertoire expansion”. Repertoire expansion may be accomplished by decreasing the impact of internal experiences (i.e., thoughts, urges, physical sensations, emotions; shifting the context away from aversive control with values interventions , and reinforcing more adaptive values-based responses. The purpose of exposure within the ACT model is not to reduce distress but to foster acceptance of emotional experience and to broaden a person’s response options in contexts where behavior has been constricted by aversive control. The focus is on fostering new learning and behavior in accordance with personal values. Given this purpose, the entire psychological flexibility model could be seen as a form of exposure therapy .

Acceptance and commitment therapy (ACT) focuses on helping patients to behave more consistently with their own values and apply mindfulness and acceptance skills to their responses to uncontrollable experiences.Acceptance and commitment therapy has been associated with improved outcomes in patients with chronic pain . Acceptance and commitment therapy starts with a discussion about what the patient wants and how they have tried to achieve these aims. Psychoeducation in ACT involves metaphors, stories and experiential exercises to demonstrate the uncontrollability and acceptability of much psychological experience. In its final phase, ACT resembles traditional behaviour therapy consisting of goal setting and graduated activity scheduling toward goals directed by values.The acceptance and commitment therapy model (ACT) is a psychological therapy that teaches mindfulness (‘paying attention in a particular way: on purpose, in the present moment, nonjudgementally’) and acceptance (openness, willingness to sustain contact) skills for responding to uncontrollable experiences and thereby increased enactment of personal values. The therapy is less concerned with eliminating unwanted thoughts, emotions and sensations (often seen as the symptoms of psychiatric disorder) and more concerned with cultivating psychological flexibility: the ability to change behaviour depending on how useful to the patient’s life this behaviour is understood to be in the long term. Acceptance and commitment therapy typically starts with an assessment of what the patient wants. Emotional control goals (eg. ‘I just want to be happy’) are reframed as a means to a more valued life (eg. through asking, ‘And if you felt happier and more confident what would you be doing more of?’). Assessment includes identifying all the things the patient has done to try to achieve their aims and how well these have worked in the short and long term.

Acceptance and commitment therapy therapists particularly seek to identify patterns of trying to control or avoid uncontrollable internal experiences, particularly those that disrupt valued living. These can range from obvious (eg. overt avoidance of difficult situations, substance use and oversleeping) to subtle (eg. ‘putting on a front’, ‘holding back’ or ‘not really listening’ during conversations). Psychoeducation in ACT consists of metaphors, stories and experiential exercises to illustrate the uncontrollability and acceptability of much psychological experience and reveal thoughts to be less powerful and limiting than usually regarded. For example, a patient might be taught to interact with a painful self belief (eg. ‘I’m a loser’) by saying the words out aloud, varying the speed, pitch or tone: treating the stimulus as a sound rather than responding to it literally. Self awareness can be developed by having the patient watch their thoughts and move their finger to indicate when thinking drifts into the past or present, instead of the ‘here and now’. ACT is not suitable for people whose cognitive functioning is impaired such that they have difficulty comprehending and generating answers to routine assessment questions or virtually no substantive memory of previous conversations. It is not appropriate for individuals who are floridly psychotic, intoxicated, require emergency medical treatment or have organic brain injury ACT is based on a holistic philosophy of science called functional contextualism.

Functional Contextualism is a philosophy underlying a modern third-wave psychotherapy known as Acceptance and Commitment Therapy (ACT). Functional contextualism has roots in behavioral and contextual sciences, which are the first and second waves of therapy, respectively. Contextualism is a name for pragmatism from a contextualist perspective an act derives meaning from its context—its history, purpose, and current situation. That is true of scientific acts as well, and thus, “truth” is a matter of “successful working” or accomplishing an analytic purpose, not correspondence between models and ontological reality. Such a pragmatic truth criterion requires a goal to be applied in functional contextualism, that goal is the prediction-and-influence of psychological events. Functional contextual assumptions are reflected in ACT in several ways. Clinically there is minimal interest in what is “true” in any ontological sense of the term and a great interest in workability (e.g., how is it working for the individual to struggle to determine whether his or her thoughts are correct?). The social and verbal context of psychological struggles is a particular aspect of the focus of ACT. Rather than trying to change the form of private experience, ACT therapists attempt to change the functions of private experiences by changing in therapy the social and verbal context in which some forms of activity (e.g., thoughts and feelings) are usually related to other forms (e.g., overt actions).ACT is based on contextual behavioral principles as augmented and extended by a basic science account of language and cognition, Relational Frame Theory (RFT).

ACT does not seek to train specific forms of thought. Rather, it attempts to untangle verbal knots by loosening the binds of language itself. For example, instead of exploring one’s successes as a way of creating a thought of “I can do it!”, in an insecure individual’s mind, ACT attempts to guide the person to notice that a thought is just a thought and to take needed actions regardless of the thoughts that might exist. The ACT approach to psychological intervention can be defined in terms of six normal psychological processes that revolve around a single core concept By specifying parallel psychopathological and change processes, the ACT model provides both a functional dimensional model of diagnosis and a model of treatment components. In ACT the counter to experiential avoidance is acceptance—the active and aware embrace of private experiences without unnecessary attempts to change their frequency or form. Acceptance in ACT is not an end in itself. Rather acceptance is fostered as a method of increasing values-based action. Acceptance is not passive in ACT—it is not a matter of tolerance or resignation. Rather, it involves a posture of active curiosity, interest, and deliberate exploration of feelings, memories, bodily sensations, and thoughts. The goal is not to reduce arousal but to increase the flexibility of responding in the presence of the repertoire-narrowing experiences , rather to increase the psychological freedom of the individual, regardless of the experiential echoes of his or her own history.

There is often an excessive literal quality to human thought. In ACT this is termed cognitive fusion. , chronic patterns of fusion can make behavior narrow, rigid, and less guided by experience. For example, a person fusing with the thought “life is not worth living” might become depressed even in the presence of everything otherwise needed to live a vital life, such as a successful job, loving relationships, or respect from others. Cognitive fusion has been shown to contribute negatively to such diverse problems as chronic pain mental health problems in children and adolescents and depression ACT attempts to undermine excessive fusion by changing the way one interacts with or relates to thoughts, feelings, and bodily sensations. ACT uses metaphors, experiential exercises, self-exploration, and writing processes as forms of values work ACT encourages the continuous redirection of behavior so as to produce larger patterns of effective action linked to chosen values.

Psychological flexibility can be defined as contacting the present moment as a conscious human being, fully and without defense, persisting or changing in behavior in the service of chosen values. This is the core target of the ACT model, and all of the processes (acceptance, defusion, being present, a noticing self, values, and committed action) together contribute to creating psychological flexibility.

ACT is not based on the psychology of abnormality, and it is not linked to syndromal classification. Psychological health is defined by the process of growth This concept of the “person” is neither active nor passive but rather interactive. At the psychological level of analysis, ACT is concerned with individuals interacting in and with a context considered historically and situationally. The psychological level of analysis blends into other levels of analysis.

ACT is based on a psychological flexibility model, not a specific technology. At the current time, there are already over 60 books in 10 languages— are specific professional or self-help books on ACT in such areas as trauma , depression , anxiety , chronic pain , anger or the management of chronic disease. . A well-known metaphor asks the person to think of two control knobs, one that sets the amount of emotional distress (e.g., anxiety high or low) and one that sets the degree of willingness to have that distress. The person comes into therapy focused on turning down the emotional distress knob, but problem is that as we try to regulate our difficult emotions we are simultaneously turning down our willingness. When anxiety is high and willingness is low, anxiety becomes something to be anxious about—it self-amplifies. This metaphor is used to focus clinically on the costs of trying to turn the emotional distress knob as a way of creating progress and to instead focus on the possibility of experiencing emotions more fully, openly, and without needless defense. ACT uses exercises to help dig down to deeply held, freely chosen values in important domains. The specific behavioral components of ACT protocols vary widely but include virtually all of the vast literature on skill-development, goal-setting, exposure, and other behavior change methods. Committed actions are designed to further values in the context of openness and awareness. what is important is the process of staying open, aware, and connected to values.

Commitments are self-selected and self-monitored, and the failure to meet them is viewed with curiosity and nonjudgment by the therapist, as a valuable source of information about barriers to value-based action. Metaphors and exercises are used to integrate these processes to focus on psychological flexibility as a whole. For example, in group work an ACT therapist might ask a person struggling with moving ahead in life to imagine that life is like driving a bus. Life “passengers,” such as fears and self-doubt, get on unpredictably and once on the bus, they tend not to leave. The person is asked to set the destination (values) and be the person (noticing self) who looks around the room (being present) and decides how to drive to move in that direction (committed action), but all of that requires allowing cognitive and emotional passengers to come along for the ride (acceptance and defusion) without turning the driving over to them despite their threats (fusion and experiential avoidance). Other group members then verbally and physically play out the passengers (fears, self-doubts) and the person acts out what happens when trying to win arguments with the passengers, and what it would be like to move ahead with the passengers following, chattering away.

ACT is recognized by the American Psychological Association as an evidence-based method for the treatment of depression, chronic pain, coping with psychosis obsessive compulsive disorder and mixed anxiety disorders. The Substance Abuse and Mental Health Services Administration has also recognized ACT as an evidence-based procedure citing the work on coping with psychotic symptoms, treating obsessive compulsive disorder and reducing worksite stress ACT is known to be helpful in many other areas such as marijuana use smoking cessation managing diabetes , and/or weight maintenance. ACT is helpful with children and adolescents as well as with adults. It is helpful in groups as well as with individuals. It is helpful with therapists in that it reduces their stress and burnout It is useful even with severe patients who are hallucinating or delusional covering the areas of depression, stress, burnout, anxiety, psychosis, pain, disease management, weight management, stigma, and smoking . Successful mediators include acceptance defusion psychological flexibility and values . The impact of ACT does not seem to be limited by region, education, ethnicity, or class. ACT is based more on metaphors and experiential exercises than intellectual argument, which greatly reduces the importance of formal education. ACT does not take a position on the content of experience, whether that is an obsessive thought, a hallucination, or a strong emotion. Rather, the usefulness of different ways of relating to these experiences is emphasized. This is an inherently collaborative, nonjudgmental, and equalizing approach. Values may differ from culture to culture, In addition to these features that make an ACT model flexible in areas of cultural diversity and social justice, as the ACT model is scaled into organizations they themselves become more accepting of diversity, more open to multiple ways of thinking, and more values based. This is not merely an abstraction. It has been shown in organizational work applying an ACT model. Controlled studies have shown that ACT can reduce prejudice toward ethnic minorities toward people in recovery from substance abuse and toward people with psychological disorders. It leads to higher behavioral commitments linked to social justice goals .

Behavior therapy can be divided into three generations: traditional behavior therapy, cognitive behavior therapy, and the more recent “third wave” of relatively contextualistic approaches In the first generation of behavior therapy it was possible to keep both commitments because traditional behavior therapists drew on a large set of basic principles drawn from the basic behavioral laboratories. Contextualism views psychological events as ongoing actions of the whole organism interacting in and with historically and situationally defined contexts. These actions are whole events that can only be broken up for pragmatic purposes, not ontologically. Because goals specify how to apply the pragmatic truth criterion of contextualism. The basic theory of human language and cognition underlying ACT, Relational Frame Theory (RFT; was developed into a comprehensive basic experimental research program used to guide the development of ACT itself Cognitive fusion supports experiential avoidance, which is the attempt to alter the form, frequency, or situational sensitivity of private events even when doing so causes behavioral. People lose contact with what they want in life, beyond relief from psychological pain. Patterns of action emerge that are detached from long term desired qualities and gradually dominate in the person’s repertoire. Behavioral repertoires narrow and become less sensitive to the current context as it affords valued actions.

ACT targets each of these core problems with the general goal of increasing psychological flexibility – the ability to contact the present moment more fully as a conscious human being, and to change or persist in behavior when doing so serves valued ends Acceptance is taught as an alternative to experiential avoidance. Acceptance involves the active and aware embrace of the private events occasioned by one’s history without unnecessary attempts to change their frequency or form, especially when doing so would cause psychological harm. For example, anxiety patients are taught to feel anxiety, as a feeling, fully and without defense; pain patients are given methods that encourage them to let go of a struggle with pain, and so on. Acceptance (and defusion) in ACT is not an end in itself. Rather acceptance is fostered as a method of increasing values-based action.

Cognitive defusion techniques attempt to alter the undesirable functions of thoughts and other private events, rather than trying to alter their form, frequency or situational sensitivity. ACT attempts to change the way one interacts with or relates to thoughts by creating contexts in which their unhelpful functions are diminished. For example, the thought could be watched dispassionately, repeated several times out loud until only its sound remains, or treated as an external observation by giving it a shape, size, color, speed, or form. A person could thank their mind for such an interesting thought, label the process of thinking (“I am having the thought that I am no good”), or examine the historical thoughts, feelings, and memories that occur while they experience that thought. Such procedures attempt to reduce the literal quality of the thought, weakening the tendency to treat the thought as what it refers to (“I am no good”) rather than what it is directly experienced to be (e.g., the thought “I am no good”). The result of defusion is a decrease in believability of, or attachment to, private events rather than an immediate change in their frequency. ACT promotes ongoing non-judgmental contact with psychological events in the environment as they occur.

A sense of self called “self as process” is actively encouraged: the defused, non-judgmental ongoing description of thoughts, feelings, and other private events. Self as context is important in part because from this standpoint, one can be aware of ones own flow of experiences without attachment to them or an investment in what experiences occur: thus defusion and acceptance is fostered. Self as context is fostered in ACT by mindfulness exercises, metaphors, and experiential processes. Values are chosen qualities of purposive action that can never be obtained as an object but can be instantiated moment by moment. ACT encourages the development of larger and larger patterns of effective action linked to chosen values. the process of contacting the present moment fully as a conscious human being and persisting or changing behavior in the service of chosen values. ACT is a psychological intervention based on modern behavioral psychology, including Relational Frame Theory, that applies mindfulness and acceptance processes, and commitment and behavior change processes, to the creation of psychological flexibility. (309-310)

**Biosocial theory**

The dialectical dilemmas are organized into three dimensions which are defined by their elements in polar opposition to one another: emotional vulnerability versus self-invalidation, active passivity versus apparent competence, and unrelenting crises versus inhibited grieving. In each of these dilemmas, behaviors on opposing poles are seen as primarily influenced by one of two factors. Developmental or biological processes, (e.g. inborn traits, temperament, genetic vulnerabilities) are associated with the poles of emotional vulnerability, active passivity, and unrelenting crises. self-invalidation, apparent competence, and inhibited grieving are shaped by social factors, namely the environment's response to expressions of emotion. Biosocial theory proposes four distinct consequences of invalidating environments that are directly linked to the manifestation of the extreme emotion dysregulation. First, accurately labeling emotions and appropriately regulating their public expressions are not learned, because the invalidating environment does not recognize these emotions as valid in the first place. Second, because the environment minimizes the difficulties of solving one's problems (e.g. the pull-yourself-up-by-the-bootstraps approach), the child does not learn distress tolerance or the ability to set goals and expectations that are realistic and achievable. Third, in an invalidating environment, extreme displays of emotion are often necessary to elicit the desired support from the environment, and are thereby occasionally reinforced, while lower level expressions of negative emotion are ignored or punished. This leads the child to “oscillate between emotional inhibition on the one hand, and extreme emotional states on the other” . Lastly, the mis-match between the child's private experience (e.g. “I am completely panicked and this feels unbearable”) and the environment's public judgment (e.g. “There is nothing to be upset about and you are overreacting”) teaches her to distrust and eventually self-invalidate his/ her own emotional experience.

In the biosocial theory, persistent and severe difficulty regulating emotions (i.e., “emotion dysregulation”) is seen as the primary dysfunction contributing to suicidal and self-harm behaviors, as well as other features of Borderline Personality Disorder (BPD). Difficulty regulating emotion is thought to develop in childhood based on the interaction between a biological predisposition to emotional vulnerability on the part of the child and an invalidating home environment. The model is transactional in that both factors need to be present beginning early in development for pervasive emotional dysregulation to develop. Emotional vulnerability is biologically based and present from birth. It is characterized by the child’s heightened sensitivity to experiencing emotion (e.g., a low threshold for an emotional reaction to an event), increased emotional intensity, and a slow return to emotional baseline. The invalidating environment is defined as one in which communication of emotion is met with caregiver responses that are inconsistent, inappropriate to the emotion expressed, and/or trivializing of the emotional experience. As a result, “the child does not learn how to adequately label or control emotional reactions”

In line with developmental theory, an invalidating environment is seen as particularly problematic early in development because young children rely heavily on caregivers to regulate their emotions and help them alleviate distress . repeated, unsuccessful child–caregiver transactions may lead to the child’s emotion regulation skills deficits, which persist into adulthood. suicide attempts and nonsuicidal self-injurious behaviors are developed as means to manage severe emotion dysregulation in the absence of more constructive coping strategies. a transactional relationship between specific biological vulnerabilities (e.g., genetic influences, abnormalities in brain systems, or frontallimbic dysfunction) and environmental risk factors (e.g., invalidation, reinforcement of emotional liability, or inadequate emotion coaching) contribute to the development of emotion dysregulation, self-harm behavior, and borderline personality disorder. Based on the biosocial theory, DBT focuses on eliminating self-injurious behaviors by teaching more adaptive coping skills for decreasing emotion dysregulation. DBT incorporates a range of cognitive–behavioral strategies, as well as practices derived from Eastern philosophy and religion (e.g., mindfulness and radical acceptance), aimed at teaching and developing clients emotion regulation skills. Although theoretical perspectives differ in focus, emotion regulation is defined as the ability of an individual to control, modify, change, and manage emotional reaction and expression to achieve one’s goals and effectively manage social, interpersonal relationships

The acquisition of emotion regulation skills occurs in the context of interactions between the child and the caregiver evolving from infancy to adolescence; transition from early reliance on caregivers for emotion regulation to independent management of emotional distress using internal strategies .At birth, infants have limited internal resources for emotion regulation and, as a result, depend on caregivers to regulate emotional distress . Caregivers help to regulate infants’ emotions by consistently responding to their needs and soothing them when they are distressed (e.g., rocking, touching, speaking to the infant with a calm tone, singing, or distracting with a favorite toy.This early regulation of emotion by the parent lays the groundwork for the child’s understanding that his or her negative emotions can be ameliorated, are understood by the caregiver, and warrant a response. On the other hand, a caregiver’s inconsistent or inappropriate response is likely to hinder the development of primitive emotion regulation skills. This, further disrupts the caregiver’s ability to be a source of emotion regulation for the infant and may facilitate the development of an invalidating environment. As infants develop into toddlerhood, caregivers focus more on verbal methods of teaching about the control and regulation of emotions, and children’s increased verbal skills allow caregivers to discuss emotions and emotion control. Preschool-aged children, though still limited in their emotion regulation capacity, are capable of using a range of methods to regulate their own emotions, including self-distraction (e.g., playing with toys, singing to self), self-soothing statements (e.g., telling self, “It’s ok”) or behaviors (e.g., thumb sucking, hugging a favorite stuffed animal), and seeking comfort from a caregiver (e.g., asking for a hug, discussing their feelings. Later in childhood, children come to rely more on active cognitive strategies, such as cognitive restructuring and problem solving, as a means to regulate emotions Thus, a parent’s response to his or her child’s emotions, as well as the parent–child relationship itself, remains critical to the development of emotion regulation skills. when the process is disrupted in infancy, the child will be at increased risk for impairments in emotion regulation skills because of deficits in emotion identification and/or expression, an inability to consistently use self-regulating strategies, an inability to rely on the caregiver for assistance, or a combination of these factors.

During adolescence, youth begin to internalize emotion regulation skills acquired through transactions with the caregiver and rely more on cognitive strategies for regulating emotions. Changes in cognitive development (e.g., increased social cognition, response inhibition, monitoring, and abstract thinking), as well as changes in social development (e.g., socialization pressures that include peer and adult expectations for mature, socially considerate, and gender-typical behavior), contribute to the increased reliance on internal, cognitively based emotion regulation strategies there is also increased vulnerability to emotion dysregulation in adolescence. Adolescents normatively exhibit an increase in emotional arousablity, novelty seeking, and motivation for peer acceptance At the same time, self-regulatory competence is not complete until late adolescence or early adulthood, because of continuing development of the frontal lobes and associated increases in neural connectivity. adolescence appears to be a time when youth are at increased risk for emotion dysregulation as a result of normal developmental processes. This risk may be heightened among individuals born into an invalidating environment with a biological vulnerability, which, according to the biosocial theory and illustrated above, inhibits the maturation of foundational emotion regulation skills early in development.

Suicidal individuals possess fewer skills for regulating emotions and what skills they have may be less developed, resembling those of younger children. From a developmental psychopathology perspective, this deficit in emotion regulation skills is the core deficit that requires remediation in order to reduce suicidal and self-harm behaviors With adolescents, the therapist also works with family members to ensure that they are not reinforcing the adolescent’s problem behaviors and that positive behaviors are being rewarded . Emotion-regulation and other coping skills are taught in the multifamily group sessions. The group is run in a didactic format, in which adolescents and parents are taught a newskill each week and complete homework on that skill. Parents and teens learn to communicate that the other person’s feelings, thoughts, and actions make sense in a specific situation. Validation differs from agreement in that validation communicates that one understands the other person’s perspective, whereas agreement indicates that one approves of the other’s thoughts, feelings, or behaviors The validation skill involves both the ability to differentiate oneself from others and the ability to engage in perspective-taking. (311-313)

**Microbiome‐based medicines**

Symbiotic microorganisms inhabiting the gastrointestinal tract promote health by decreasing susceptibility to infection and enhancing resistance to a range of diseases.Microbiome‐based medicines include biomarkers, where patients are screened monitored and stratified, and therapeutics, where there are currently nine forms of therapeutics: dietary interventions, prebiotics, probiotics, synbiotics, antibiotics, faecal microbiota transplantation, phage therapy, live biotherapeutics and microbiome mimetics.The gastrointestinal (GI) microbiome play an integral role in overall homeostasis; alterations lead to the development and progression of disease. These complex communities contain between 100 and 1000 bacterial species all of which have the ability to interact with the host in different ways. The concept of altering the GI microbiome to improve health outcomes is well established in modern medicine. Microbiome‐based medicines can fall into two categories, microbiome‐based biomarkers, and therapeutics

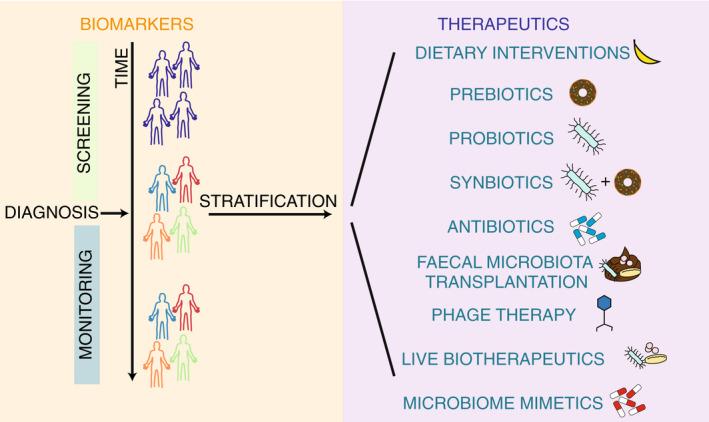


Fig.48. Overview of the different uses of the microbiome for medicine. Microbiota uses include biomarkers (orange box), where patients are screened monitored and stratified, and therapeutics (purple box), where there are currently nine forms of therapeutics: Dietary interventions, prebiotics, probiotics, synbiotics, antibiotics, faecal microbiota transplantation, phage therapy, live biotherapeutics and microbiome mimetics.

 Advances in metagenomic sequencing technologies have improved characterisation of microbial communities and provided associations with disease phenotypes. In addition to the identification of biomarkers for diagnosis of disease, microbial biomarkers are being developed to stratify patient cohorts prior to treatment to ensure patients receive the best treatment for them. biomarkers can be used to monitor patients following treatment to ensure treatment efficacy

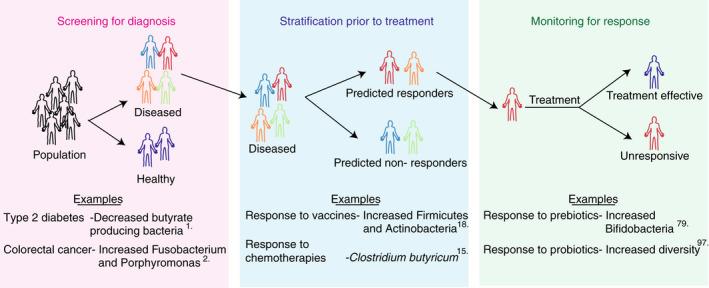


Fig.49.Categorisation of microbiome‐based biomarkers for disease. Microbiome‐based biomarkers can be classed as tools for screening for diagnosis (pink box), stratification prior to treatment (blue box) and monitoring for response to treatment (green box).

Understanding interactions between the microbiome and therapeutic response provides the opportunity for tailored interventions to achieve optimal outcomes or avoid adverse reactions. In this context, microbiome‐based patient stratification to appropriately target existing therapies to specific patients and to define responses to vaccines and other therapies, Improved patient responses to chemotherapies, radiation and immunotherapies have been associated with a more diverse GI microbiome and key bacterial species.Changes to microbiome composition, specifically diversity loss and a decrease in bacterial load within the GI system, are associated with a deleterious effect on the host.

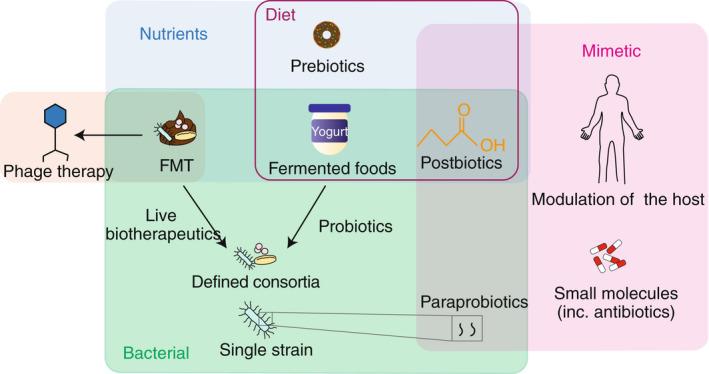


Fig.50. Categorisation of microbiome‐based therapeutics. Microbiome‐based therapeutics can be categorised as nutrients (blue box), bacterial (green box), or microbiome mimetics (pink box). Many therapeutics can be found within the diet (purple box) but are composed of components that are nutrient, bacterial and mimetics.

Diet plays an essential role in health and disease, with intake of dietary fibres from foods, such as whole grains, resistant starch and fruits, being clearly beneficial for the development of a diverse microbiome.Many dietary fibres act as prebiotics, components in food that are used by the microbiome, confer a health benefit, are easily administered, and support numbers of beneficial bacteria. Currently, there are five main classes of prebiotics:

(1) readily fermentable dietary fibre,

(2) phenolics and phytochemicals,[https://pmc.ncbi.nlm.nih.gov/articles/PMC9322325/](https://pmc.ncbi.nlm.nih.gov/articles/PMC9322325/#apt17049-bib-0063)

(3) human milk oligosaccharides,

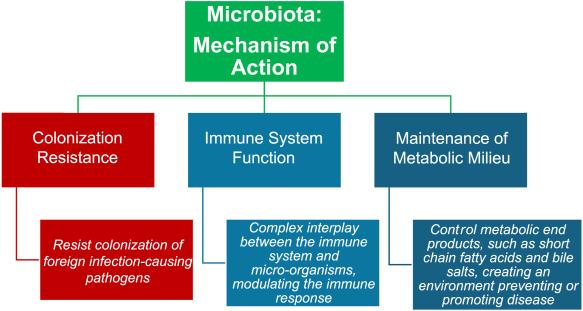
(4) other oligosaccharides (i.e. fructooligosaccharides[FOS],galactooligosaccharides [GOS]and inulin) and (5) Conjugated linoleic acid and polyunsaturated fatty acid.

Microbiome mimetics describe any intervention that replicates the interaction between the microbiome and the host, that yields a therapeutically beneficial outcome including bacterial derived products, small molecules, conventional therapeutics or host derived products.  Organoids are enclosed, three‐dimensional (3D) cultures that mimic the multicellular structure from the corresponding tissue. Organ‐on‐a‐chip is a method that combines microfluidics and cell culture to generate mini human organs on a chip. The complex network of microscopic organisms living on and within humans refer as the microbiome , produce wide array of biologically active molecules that shapes our health. Disruption of the microbiome is associated with susceptibility to a range of diseases such as cancer, diabetes, allergy, obesity and infection. Microbiome based therapies are being developed to treat these diseases by transplanting bacteria or Bacterial derived byproducts into a diseased individual to reset the recipient’s microbiome and restore health.

Millions of years of co-evolution between microbiome and mamalian host has resuklted in mutualism and homeostasis. Microbial diversity is a hallmark of healthy microbiome as the trillions of microbes act in concert to support host health. This mtualistic relationship can be breached by environmental factors , such as antibiotic use or dietary changes taht lead to decreased bacterial diversity or skewed relative abundance of bacterial species, the change sin microbiome composiiton are referred to as microbial dysbiosis. Altered odr dysbiotic intestinal microbial communities are associated with disesase statse such as cancer, diabetes, allergy, obesity, neurological disorders , and infectious diseases. Thus resetting the microbiome with a composiiton of bacteria from healthy individuals can restore health. Intestinal bacteria are regualtors of the host immune system that promote immune ducation, immuntolerance and resistance to pathogens. The collective microbiome is referenced as a distinct organ system that synthesizes signaling molecules taht shape host physiology. A dysbiotic microbiome that fails to function properly is analogous to an organ system failure and a microbiome based transplant can be considered a bacterial organ transplant to replace the dysbiotic failing organ with a healthy one. Crosstalk between the microbiome transplant and the host immune system has an important role in determining transplant success or failure. Chronic intetsinal dysbiosis is associated with elevated expression of proinfalmamtory mediators taht are hallmarks of various chronic inlamamtory diseases. Reciprocal to dysbiosis driving aberrant immune responses , host inflammation can cause intestinal dysbiosis. Microbiome based tehrapies can be catgorized into following approaches: prebiotics, probiotics, synbiotics fecal microbiota transplantation (FMT), live-biotherapeutics and postbiotics.Probiotics, prebiotics, and have become key interventions for restoring and maintaining a balanced gut microbiota .

Prebiotics are non-digestible food components that selectively stimulate the growth and activity of beneficial intestinal bacteria. Common prebiotics include dietary fibers, such as inulin, fructooligosaccharides (FOS), and galactooligosaccharides (GOS). Prebiotics act as substrates for beneficial microorganisms, promoting a beneficial intestinal environment and increasing microbial diversity and metabolic activity. This may lead to enhanced digestion, an improved immune response, and reduced inflammation.  Carbohydrate based substances , polyunsaturated fatty acids and polyphenols as well as non digestible oligosaccharides such as inulin and its hydrolysisi products exert prebiotic effects. An ideal prebiotic should resist the actions of acids, bile salts and other hydrolyzing enzymes in the intestine , be fermented by intestinal microbes and not being absorbed in the upper gastrointestinal tract..Prebiotics prevent pathogen growth by increasing intestinal organic acids, reducing luminal pH levels and establishing a stable popuılation of commensal bacteria that compete with invading pathogens for nutrients. Efficacy of prebiotic therapy is dependent on beneficial microbe salready residing within the host, a condition that may not be met in dysbiosis. Probiotics are live organisms mainly lactobacillus, bifidobacterium and saccaromyces , that do not reside in mamalian host but provide health benefits when when consumed in sufficient quantities.  Synbiotics are combinations of probiotics and prebiotics that have synergistic advantages. The rationale behind synbiotics is that the prebiotic component provides a specific substrate that supports the growth and activity of probiotic strains, that would increase the therapeutic outcome because the prebiotics guarantee the beneficial bacteria not only to survive in the gastrointestinal transit but also become active and exert their health-promoting effects Clinical research on synbiotics has investigated their potential applications in various health areas, including gastrointestinal diseases, metabolic disorders, and immune system modulation. Specific synbiotic formulations have reduced the incidence of necrotizing enterocolitis in preterm infants.

Fecal microbiota transplantation, (FMT)known as bacterotherapy is a procedure in which fecal matter from a healthy donor enters the recipient’s gastrointestinal tract to re-establish a healthy microbial . FMT can restore the recipient’s gastrointestinal bacterial diversity and bacterial –derived metabolites termed the metabolome. This is accomplished using colonoscopies, enemas, or capsules. The aim of transplanting healthy fecal matter is to restore gut balance by repopulating it with bacteria that are beneficial to the body and eliminating harmful viruses. The procedure begins by selecting a donor with no family history of autoimmune, metabolic, or malignant diseases, followed by infection testing of the donor. The fecal matter from the donor is suspended in a solution containing either water or saline and is strained to eliminate particulate matter. The resulting concoction is delivered to the recipient using numerous means, such as a nasogastric or nasojejunal tube, esophagogastroduodenoscopy, colonoscopy, or retention enema.Fecal microbiota transplantation (FMT) has a rich history in ancient Chinese medicine. The earliest records of fecal therapy in China, dating back to the 4th century AD, were attributed to physician Ge Hong. He described the use of a fecal slurry known as “yellow soup” to treat severe gastrointestinal issues, including diarrhea and food poisoning. Live bio-therapeutics are a single bacterial species or selected combination of bacteria , that can colonize the intestine an are designed to provide clinical benefitm for a particular disease. They are identified and isolated from fecal bacterial populations. Postbiotics are soluble components of microbial cells or derived metabolites that can provide therapeutic benefits. Microbiome based therapies are designed to reshape the composiiton of resident microbial communities and restore health via stimulation of the immune system by decreasing inflamamtion or enhancing its efefctor activity. The gastrointestinal (GI) microbiota, the micro-organisms that reside within the digestive tract, include bacteria; archaea; fungi; yeast; and viruses. plays many essential roles in promoting health, including maintaining metabolic homeostasis, reinforcing immunity, and nutrient extraction.



**Fig.50. key mechanisms of action of the microbiota in contributing towards healthy states. Restoration of these mechanisms underpin the efficacy of fecal microbiota transplantation and other microbiome therapeutics.**

A healthy microbiota is capable of resisting colonization of infectious pathogens. From birth through adulthood, there is a complex interaction and evolution among the microbiota and the immune system<https://www.gastrojournal.org/article/S0016-5085(24)04915-1/fulltext>, taht regulate and promote the growth of healthy microbes in the gut microbiota, whereas a healthy microbiota creates signals promoting growth of immune cells moderating immunogenic responses to stimulants and foreign pathogens. The metabolic environment in the intestine is thought to have an impact on a variety of diseases. The complexity of the interaction between the microbiota and the human body has been outlined by the 3 most common bridges: colonization resistance, immune system function and the resultant metabolic milieu. Precision therapeutics, referred to as personalized medicine, tailors treatments to an individual’s unique genetic, molecular, and/or clinical characteristics by harnessing advanced technologies, such as genomics, metagenomics, and metabolomics. Precision microbiome therapeutics (PMT) is defined as a personalized approach where microbiome-based therapies are customized based on a unique composition, genetic characteristics, and functional attributes.<https://www.gastrojournal.org/article/S0016-5085(24)04915-1/fulltext>   The human microbiome, a complex ecosystem of microorganisms residing in and on the body, plays a pivotal role in the regulation of a wide range of physiological processes. The therapeutic potential of the microbiome extends beyond the gut, with emerging research highlighting its role in diverse areas such as cancer immunotherapy, neuroimmune modulation, and the gut–brain axis.

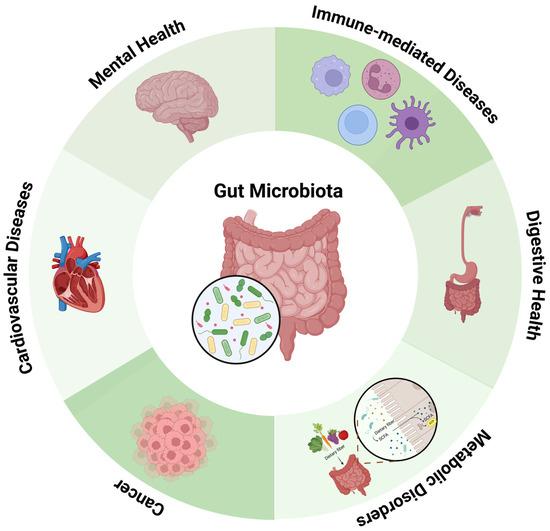


Fig.51.Gut microbiota and disease connections (Created in [**https://BioRender.com**](https://biorender.com/)).

Breakthroughs in microbiome editing therapeutics have paved the way for innovative treatments that precisely target the microbial genes in the human gut. These emerging techniques, mostly CRISPR and base editing, offer promising approaches for manipulating microbial communities in situ with high specificity and efficacy, showing great potential for treating various diseases. This in situ technique manipulates the microbiome in its native setting. Although microbiome transplants can create large-scale changes but lack specificity, in situ-engineered microbiomes are designed to target specific bacteria, limiting their impact on the rest of the microbial community. Base editing is a genome-editing technique that enables precise modification of specific DNA bases without causing double-strand breaks or relying on homologous recombination, without introducing double-strand breaks or homologous recombination. This fusion technology combines a catalytically weakened CRISPR-associated nuclease (Cas) protein and nucleobase deaminase enzyme. The guide RNA guides these complexes to the target DNA sequence, where the deaminase catalyzes chemical alterations and produces a point mutation. This method allows for accurate genetic modifications with a lower risk of unintended genomic changes. the microbiota itself is responsible for several drug modifications, such as activation, inactivation, and even toxification.

Engineered microbiomes, or synthetic microbial communities, are designed to perform specific functions in a host or environment for precise interventions in health and disease management. The development of synthetic microbiomes involves the careful selection and integration of microbial species with specific traits to achieve targeted effects. This process can be achieved through two approaches: bottom-up and top-down approaches. The bottom-up approach isolates and assembles specific microbial strains into an organized community with defined functions. This method allows for the complete and precise control of the community, composition, and interactions. The top-down approach involves altering existing microbial communities by adding or deleting members of the community to change community behavior and function Advances in genetic engineering and synthetic biology have enabled the programming of microbial consortia to execute complex tasks, including biosensing, metabolic production, and immune modulation. Engineered microbiomes have significant potential in precision medicine by facilitating treatments customized to each patient’s unique characteristics. In disease therapy, engineered microbiomes can modulate metabolic pathways, generate therapeutic compounds, or outcompete pathogenic microbes to treat conditions such as IBD, infections, and metabolic disorders. Engineered gut microbiota composition also controls drug metabolism, thereby improving efficacy and decreasing adverse effects. In addition, engineered microbial communities modulate immune responses, offering potential treatments for autoimmune diseases and allergies.

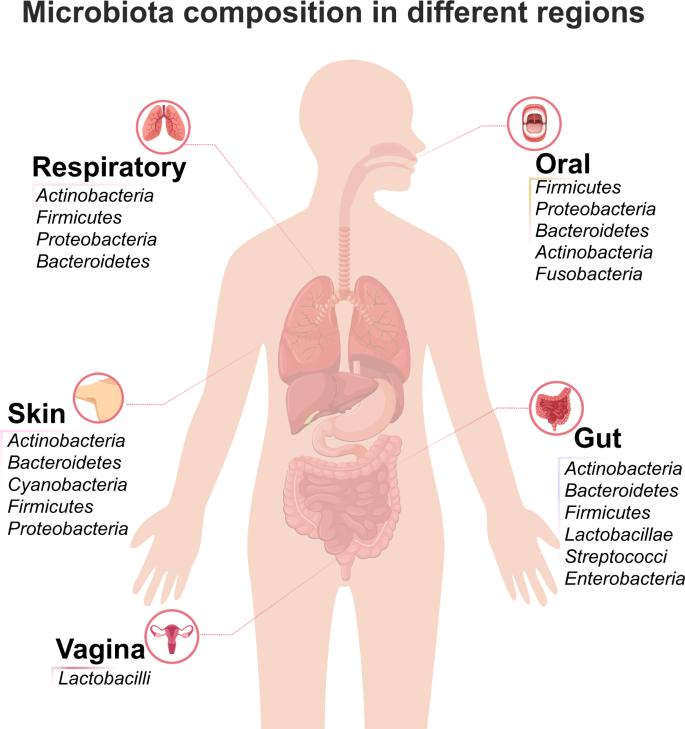


Fig.52.Human microbiota composition in different locations. Predominant bacterial genera in the oral cavity, respiratory tract, skin, gut, and vagina are highlighted

Microbiota is also localized in other regions including the oral cavity, lung, vagina, and skin. Oral microbiota is considered the second largest microbial community in human.[9](https://www.nature.com/articles/s41392-022-00974-4#ref-CR9) The oral cavity can be further divided into multiple habitats of microbiota, including saliva, tongue, tooth surfaces, gums, buccal mucosa, palate, and subgingival/supragingival plaque, which may exhibit substantial and rapid changes in composition and activity, owing to the factors such as changes in pH, gene mutations, and interactions among the bacteria.  Although healthy human lungs were long considered sterile, numerous studies have demonstrated that microbiota is also present in lung tissues. The physical and chemical differences of skin regions create distinct composition of microbiota.Intestinal microbial balance is closely relevant to human diseases and health. Compared with other regions of the body, the human gastrointestinal (GI) tract contains an abundant microbial community which gathers ~100 trillion microorganisms.In healthy conditions, the gut microbiota exhibits stability, resilience, and symbiotic interaction with the host. Gut microbiota is composed of bacteria, yeasts, and viruses. A healthy microbiota community often demonstrates high taxonomic diversity, high microbial gene richness and stable core microbiota.[https://www.nature.com/articles/s41392-022-00974-4](https://www.nature.com/articles/s41392-022-00974-4#ref-CR18) The relative distribution of microorganisms is unique between individuals and may undergo variations within the same individual. In human, gut microbiota may vary due to age and environmental factors (for example, medication usage).

Humans are born with and form a large community of symbiotic and pathogenic microbes, which inhabit in the gut, skin, mucosal passages, and form a stable community that is resistant to external pathogens. Microbiota, that provides resistance the colonization of invading pathogenic species, is crucial shield in protecting us from exogenous microorganisms. gut microbiota varies in different anatomical parts of the GI tract. The GI tract digests proteins as well as sugars from foods. Metabolizing polysaccharides and specific proteins require multiple enzymes produced by various bacteria. due to the necessity of competing with foreign bacteria, gut bacteria have developed various ways of suppressing competitors, including the secretion of diverse bacteriocins. Microbiota that exhibits distinct characteristics and compositions in different organs , interacts with multiple biological processes of the host. The human immune system is comprised of innate and adaptive immune responses, both of which have been shown to extensively interact with microbiota. The innate immune response has critical role in maintaining a homeostatic environment by eliminating pathogenic bacteria and regulating the adaptive response to microbiota.The GI tract hosts a large number of immune cells, which constantly communicate with the gut microbiota. The maturation of the immune system needs the development of commensal microorganism.

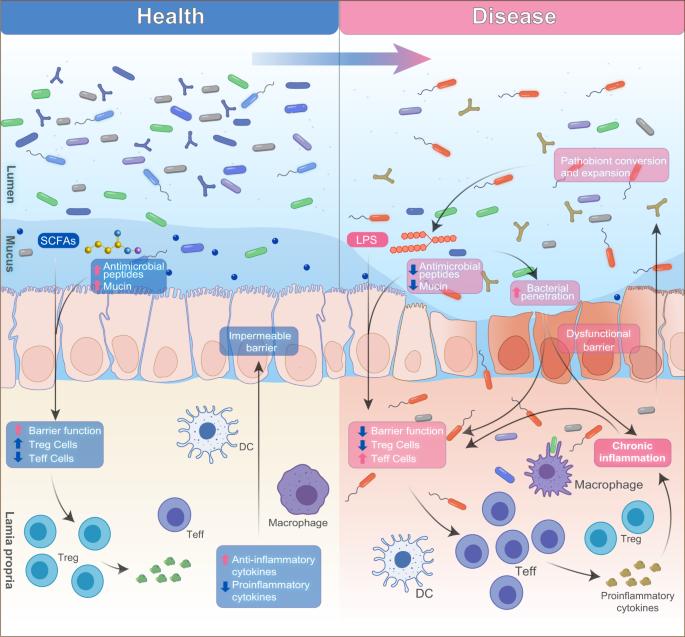


Fig. 53.Factors affecting microbiota-associated chronic inflammation in healthy and disease state

Human immune system is closely related to the microbiota as a complex symbolic relationship during the co-evolution of vertebrates and microbiota.[https://www.nature.com/articles/s41392-022-00974-4](https://www.nature.com/articles/s41392-022-00974-4#ref-CR99) The vertical transmission from the mother’s microbiota to the child at birth is considered the initial introduction of microbiota to the child. Infants born by Cesarean section are colonized with bacteria of the epidermal origin, which might link to higher risk of developing allergies and asthma compared with infants who received initial microbiota from the maternal vaginal flora  Such difference in immune system and microbiota would be gradually eliminated during growth. the infant’s microbiota stabilizes at ~1-year-old and resembles that of adults. The neonatal immune system develops under the impact of dynamic microbiota.[https://www.nature.com/articles/s41392-022-00974-4](https://www.nature.com/articles/s41392-022-00974-4#ref-CR101) In addition to the microbiota transmission during birth, breastfeeding also plays crucial roles in the establishment of infant immune system as well as microbiota. The gut microbiota has been closely connected to immunological response due to the fact that enteric microorganisms promote macromolecules and antigens through the gut epithelium.[https://www.nature.com/articles/s41392-022-00974-4](https://www.nature.com/articles/s41392-022-00974-4#ref-CR102) The principal component of bacterial flagellum, namely flagellin, elaborates the relationship between gut epithelial integrity and host immunity.

The oral cavity is another important habitat where the microbiota could colonize. Different from the gut environment, the oral cavity contains both hard surface of teeth and epithelial surface of mucosal membrane. Approximately 50 species (1000 sub-species) exist in the oral microbiota. Due to the constant exposure to saliva, oral microbiota acquired the feature of avid adherence, which guarantees their colonization and resistance to the forces of fluid flow.    Like gut and oral tissues, the lungs also present a complex bacteria community. The lung microbiota is relatively dynamic as a result of the microbiome immigration and elimination via aspiration, cough, or mucociliary clearance.  The human skin, like gut, is also colonized by a dense community of microbiomes composed of highly diverse communities. It has been discovered that the skin microbiota is composed of prokaryotes (bacteria and archaea) and eukaryotes (fungi, metazoic parasites). Vaginal microbiota is critical in protecting the host from invading pathogens via colonization resistance.

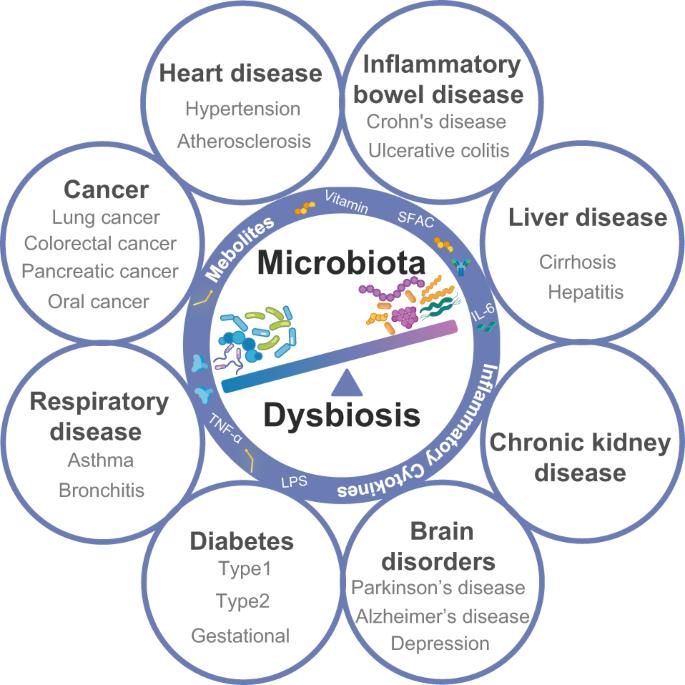
[](https://www.nature.com/articles/s41392-022-00974-4/figures/4)

Fig.54.Human microbiota dysbiosis contributes to various diseases

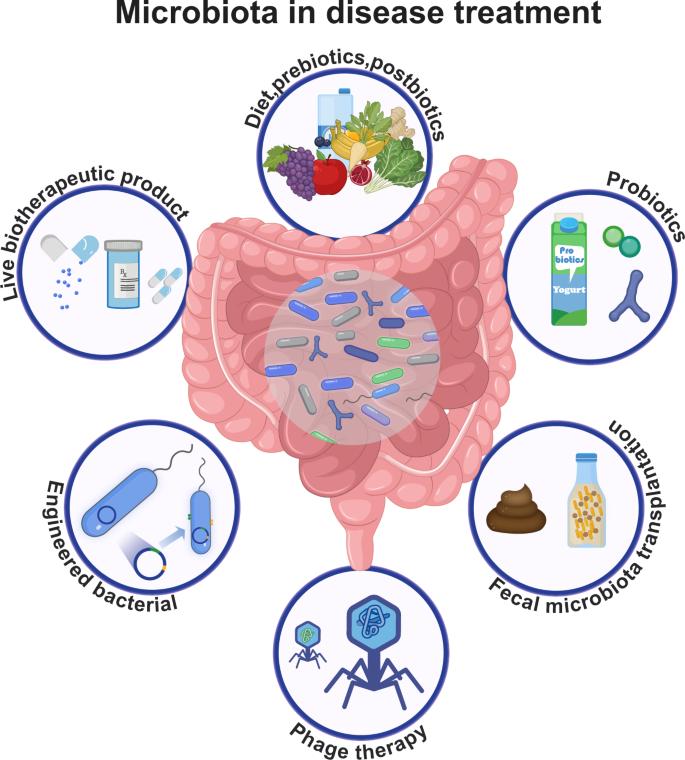


Fig.55.Strategies to modify gut microbiota for disease treatment

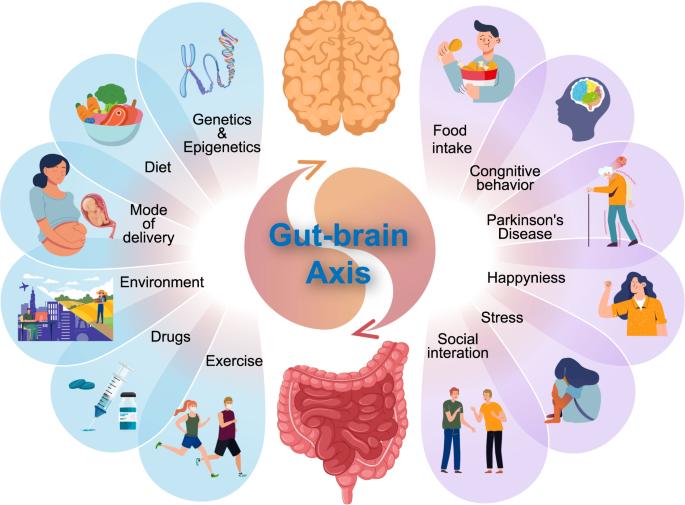


Fig.56.Bidirectional gut-brain axis interactions and the common factors contributing to the gut–brain activity (314-319)

**Trauma-informed and** **Trauma-focused psychotherapy**

Trauma is defined as exposure to death, severe injury, or sexual violence, which can occur directly to an individual through witnessing the event, indirectly, or via repeated exposure to distressing details. The effects of trauma vary among individuals and populations, manifesting in diverse ways and significantly impacting survivors. Traumatic incidents can profoundly affect cognitive, emotional, and physical functioning. Trauma-informed therapy is a framework designed to acknowledge and address the impact of traumatic experiences on individuals' lives. Traumatic incidents can distort emotions, memory, consciousness, and self-perception. Trauma also affects interpersonal connections and attachment to others while influencing brain and body function.  Experiencing trauma can significantly alter an individual's emotional and psychological development.

Trauma-informed therapy emphasizes shifting the focus from "What's wrong with you?" to "What happened to you?" This approach provides a framework for understanding and responding to the effects of trauma, prioritizing the creation of a safe, supportive, and empowering environment for individuals who have experienced trauma. This therapy involves recognizing the prevalence and impact of trauma, understanding its effects on individuals, and integrating this awareness into all aspects of therapeutic practice. Trauma-informed therapy, that goes beyond treating trauma symptoms, offering a holistic approach that acknowledges and addresses the broader effects of trauma on individuals' lives. This approach encompasses various therapeutic methods, including cognitive, emotional, and behavioral techniques, to address traumatic experiences while recognizing trauma as a fundamental aspect of the therapeutic process , encompasses a range of therapeutic modalities aimed at addressing the complex needs of individuals affected by trauma. These therapies are applied in behavioral health contexts to create a safe and supportive environment that fosters healing and resilience while integrating trauma awareness into every facet of care.Trauma-informed therapy is used to address a range of mental health conditions such as PTSD, acute stress disorder, reactive attachment disorder, disinhibited social engagement disorder, prolonged grief disorder, and adjustment disorders, where trauma plays a significant role in symptom development or etiology Trauma-informed approaches such as dialectical behavior therapy (DBT), mentalization-based therapy (MBT), and eye movement desensitization and reprocessing (EMDR) can help address trauma-related distress, including flashbacks, nightmares, anxiety, and depression.Trauma-informed therapy can also improve the management of borderline personality disorder symptoms by promoting skills such as emotional regulation, interpersonal effectiveness, and distress tolerance.

 Integrating trauma-focused cognitive behavioral therapy (TF-CBT) into the treatment of substance use disorders can be particularly effective due to the connection between trauma and substance use. Psychosis is a leading global cause of disability and mortality, with evidence suggesting that developmental trauma may contribute to psychotic symptoms in adulthood. Clinicians might find it beneficial to incorporate the following areas into treatment—emotion regulation, psychological acceptance, interpersonal skills, attachment, dissociation, and trauma memory reprocessing. Modalities such as exposure therapy, TF-CBT, and EMDR including components designed to help individuals address and work through their traumatic memories, cognitive patterns, and perceptions of traumatic experiences.  have demonstrated efficacy in treating trauma.

Common elements of trauma-informed therapy include:

* Psychoeducation: Providing information about stress reactions, coping with trauma reminders, and managing distress.
* Emotion regulation and coping skills.
* Imaginal exposure.
* Cognitive processing, restructuring, and meaning-making.
* Targeting emotions such as trauma, guilt, shame, anger, grief, or sadness(320)

**Trauma-focused (TF) psychotherapy**

Trauma-focused (TF) psychotherapy is defined as any therapy that uses cognitive, emotional, or behavioral techniques to facilitate the processing of a traumatic experience, with the trauma focus being a central component of the therapeutic process. Trauma-focused (TF) psychotherapy uses different techniques to help people process traumatic experiences. Some involve visualizing, talking or thinking about the traumatic memory. Others focus on changing unhelpful beliefs about the trauma. TF therapies usually last about 8-16 sessions.Trauma-focused cognitive behavioural therapy (TF-CBT) for children and parents is an evidence based treatment approach for traumatised children experiencing sexual abuse, domestic violence, traumatic grief, terrorism, disasters and multiple traumas. The model of TF-CBT is a ﬂexible, components-based model that provides children and parents with stress management skills prior to encouraging directdiscussion and processing of children s traumatic experiences. TF-CBT components are summarised by the acronym

PRACTICE:

Psychoeducation,

Parenting skills,

Relaxation skills,

Affective modulation skills,

Cognitive coping skills,

Trauma narrative and cognitive processing of the traumatic event(s),

In vivo mastery of trauma reminders,

Conjoint child-parent sessions, and

Enhancing safety and future developmental trajectory.

Children experience traumatic events before reaching adulthood. International studies document that child sexual abuse, physical abuse or domestic violence affect up to 25% of children around the world, with potentially serious and negative effects lasting into adolescence and adulthood if left untreated Natural disasters, motor vehicle accidents, community and school violence are also common, with many children being negatively impacted by such exposure. Although some children never experience war, terrorist acts or refugee status, many others do. These events are also potentially traumatic and can result in long lasting negative emotional sequelae. While most children are resilient following trauma exposure, some are not. Recent research suggests that genetic makeup inﬂuences how children respond to traumatic events . Other factors can serve as risk or protective factors following children’s exposure to trauma. These include the degree of exposure to the index trauma, including threat to the  
child’s life and threat to or loss of life of family members; the availability of social support; past history of other traumas; the child’s preexisting history of anxiety disorder; parent’s history of psychiatric disorder; the presence of parental posttraumatic stress disorder (PTSD) in response to the index trauma; and the amount of time the child spends viewing television coverage of the index traumatic event

Children may develop different types of emotional or behavioural problems in response to traumatic exposure. These can be divided into problems of affect, behaviour, and cognition.Affective problems may include sadness, fear, anxiety or anger. Some children may develop excessive moodiness, or develop difﬁculty in controlling or regulating their moods and emotional states (affective dysregulation). Affective dysregulation can arise from a variety ofcauses, and it is important for the therapist to criticallyanalyse the source of the child’s problems. For example, a child may feel sad because she is overly responsive to negative stimuli (her/his feelings are easily hurt and doesn’t know how to take a compliment or too shy to approach new peers etc), is underresponsive to positive stimuli or does not have adequate skills to access positive stimuli . The child seems happy sometimes but later reinterprets that experience more negatively. Behavioural problems may take the form of avoidance of trauma reminders (any person, place, thing or situation that reminds the child of the original trauma). Avoidance is a hallmark of PTSD, but it is also normal for children to want to avoid talking about painful or difﬁcult subjects. Following traumatic exposure children may also develop new oppositional behaviours (which may result from anger or feelings of betrayal in reaction to the unfairness of the traumatic event). Children may develop new difﬁculty in separating from adults (school refusal).The efficacy of trauma-focused therapies for reducing symptoms of PTSD among individuals who experienced a range of traumatic events including combat-related trauma, sexual assault, domestic violence, motor vehicle accidents, and childhood abuse has been well established. (321-322)

**Testimony therapy**

Testimony therapy, has been developed as a type of therapy that places the trauma within the cultural sociopolitical context in which it occurred.Testimonial psychotherapy, a socially and politically rooted theory, has been proven to be effective in alleviating symptoms of posttraumatic stress disorder with populations of varying races and ethnicities from all parts of the world. All of the people who have participated in testimonial psychotherapy have also been victims of torture and persecution by oppressive governments in their countries of origin. The objective, subjective, public and private aspects of testimonial psychotherapy are reflected in the fact that it is a socially and politically rooted theoretical framework for providing psychiatric care for people who have experienced trauma. It allows for a process of transforming private pain into political or spiritual dignity and shifts the focus of therapy to be political, not clinical. Testimonial psychotherapy does this through a therapeutic process that entails a loosely guided narrative, or testimony. After each session, or a set of sessions, the clinician and/or interpreter transcribe the testimony. The impact of giving/taking a testimonial on healing from trauma induced by political oppression was first documented in the early 1980s. The “birth” of testimonial psychotherapy has been placed with an article first published in 1983 by two Chilean psychologists, Ana Cienfuegos and Cristina Monelli. It had entered both the realm of psychological healing and social justice.

In the early 1970’s Cienfuegos and Monelli (1983) started taking testimony from survivors of political torture resulting from the Pinochet regime. Their original aim was political in nature--to collect information to be used against the regime. However, the psychologists noticed relief from posttraumatic stress symptoms as a result of the testimony taking process. Soon after they published their findings, others started using this method around the world. Testimonial psychotherapy has been used, with women who have survived politically based torture focusing on survivors of sexual abuse and torture, with Bosnian refugees living in Chicago with a group of the “Lost Boys of Sudan,” and testimony taken from Holocaust survivors. Although variation exists, a basic format is followed that includes important key components such as reconnection to the community, a ritual space, a bound document, the power of a witness, and opportunities for the person giving the testimony to have control over what is documented through a process of editing. Testimonial psychotherapy is a politically and socially rooted therapy working to create a story based in a person’s direct experience of political oppression as well as addressing such topics as: sexual development, sexual trauma, marriage, housework, pregnancies, births, motherhood, divorce, work, and age. When determining if a person has been traumatized by an event either acted upon them, someone they know, or something they witnessed, the standard used has been the Diagnostic and Statistical Manual of Mental Disorders (4th ed., text revision; DSM-IVTR; American Psychiatric Association, 2000). in order to present a defense or evidence in support of a legal case involving mental health, a diagnosis from the DSM-IV-TR must be given. . According to the DSM-IV-TR an event is traumatic if it is physical in nature, or revolves around physical, tangible loss or threat of some sort of tangible loss, witness of a physical loss, or learning of a loss or threat of loss to a close friend or relative.

There is no mention of emotional abuse, chronic discrimination, name-calling, being ignored, internalized racism, being the target racial profiling, incarceration, and the list could go on, as events that have the potential to be traumatizing. Actual physical threats to a person of color’s life, family, friends, and/or belongings still do happen, events that lead to RBTS are, “chronic, systemic, invisible assaults on the personhoods of ethnic minorities” Testimonial psychotherapy is relational. Two individuals, a survivor and a listener, enter into a relationship that centers on the task of documenting and communicating the survivor’s story. As in other psychotherapies, the relationship must be safe, trusting, and caring. In testimony, the listener must have adequate knowledge of the historical events through which the survivor lived. The story belongs, first and foremost, to the survivor; in some ways, however, the story belongs to the relationship The testimony is relational in another sense: the listener plays a major role in facilitating the unfolding of the narrative and reframing the story.

Testimonial psychotherapy reframes the life history of the survivor. the process of testimonial psychotherapy bears a potential for empowerment. the clinician is in a dynamic to acknowledge the power of the testifier and assist in the empowerment process. It is a picture of two sitting beside instead of one sitting over, or above, another. This power shift and framework of empowerment provides a setting for healing from the effects of RBTS through the words of the person who has been the victim of sociohistorical political settings that cause traumatic symptomatology. This switch can allow space for a huge moment of reclamation of personal experience and words for the testifier. By using the story and words of the person, it provides a setting in which to frame and validate the person’s experience in all of its subjective and objective parts. the whole process of testimonial psychotherapy is done verbally. One does not have to know how to read or write to create the bound testimonial as it is recorded and then transcribed. It is accessible to people from all levels of education, experience, and socioeconomic backgrounds. Testimonial psychotherapy shifts away from giving the testimony as an endeavor to “heal” the individual to giving the testimony as an endeavor to create a sociohistorical politically grounded document about what was happening in the person’s life—in its entirety before, during and after the trauma.

Testimonial psychotherapy has a purpose— to externalize traumatic stories in order to create a social, historical, and political document. It can acknowledge the effects of the intergenerational transmission of trauma and simultaneously how RBTS has affected the individual in their immediate past, present and future. It creates documentation that can be used to educate future generations about the struggles and survivals of a whole community. This bound testimony can be employed in many ways. It can be: used to argue a case seeking political asylum, made into a play, given to a therapist to enhance treatment, shared with.The primary purpose of testimonial psychotherapy is the creation or re-creation of a traumatic event(s) to produce a bound document. an amazing secondary gain to this process is that it has been proven and observed to alleviate some PTSD symptoms. Testimonial psychotherapy may alleviate feelings of shame by linking people together who have similar traumatic experiences. There is a lot of power in hearing people tell their story of the ways in which they have been affected

If an archive of RBTS testimonies were available for whole communities to read, others could gain strength from a feeling of For various reasons, people cope with stress, trauma, and race-based stress and trauma in different ways. Some of what determines how a person is able to cope depends on family, family strength, family stories, family support, racial identity development (including how positive or negative group image the person has about their own group), faith, and what a person is born with—their temperament.In the cases where people are not born into spaces with a lot of support, whether it is family-centered or community, they may not have had the chance to learn some of the coping mechanisms. Testimonial psychotherapy could be helpful in all cases, to connect people to others who may have been given more coping mechanisms to give some level of protection from the affects of RBTS. In addition to connecting people through their testimonials to gain strength, solidarity, and awareness of coping skills, making testimonies visible and public through something like an archive may also give some sense of normalizing the symptoms. This act of normalizing can work to reduce shame. Normalizing the symptoms could also serve to reduce feelings of isolation that are present with trauma. Not only the act of giving the testimony, but also the knowledge that others are doing the same could begin to help a person reconnect with their own sense of belonging to a community. Testimonial psychotherapy has a component that is used to connect one’s testimonial to the community . Feelings of powerlessness and hopelessness are common when a person has experienced a traumatic event

Testimonial psychotherapy has the potential to capitalize on the power and hope a survivor has through providing a space to talk about personal, familial, and/or community victories and strengths. Having the opportunity to let a testimony unfold in an organic way over a course of time may allow more freedom, space, and chances for reframing and restorying to occur. The goal of creating a sociohistorical and political document should stay in tact. Having an open-ended number of sessions supports a belief and practice of recognizing that everyone works at different paces. Allowing for unlimited sessions recognizes that this process can be empowering and painful at the same time and that people have different thresholds for how long they are able to sit with the power and pain involved in their trauma story. It has the potential to be utilized as a longer, or even long-term therapy. Another point of adaptation is to add more chances for positive reframing throughout the process There are times when a clinician would not treat a person in an intimate partner violence situation until the person got out of the relationship . building coalitions with other organizations in the community to provide opportunities for the testimonies to be part of a larger community or communities’ wide project(s) could be something already set in place by those taking testimonies or a joint project between those giving testimonies and the witnesses. A situation could be imagined where testimonies could be gathered documenting the ways in which the operation of incinerators in a community has affected the health of the community. These testimonies could be presented to local (or larger) government in conjunction with organizations already working on closing down the incinerators.

National Sorry Day was started in Australia in 1998 after an investigation was done looking at the removal of Aboriginal children from their families. These children have been referred to as the Lost Generation. Sorry Day was started to acknowledge the wrongdoings to the families and as a remembrance of the mistreatment of the Aboriginal people. With open acknowledgement comes open space for a healing process. The adapted version of testimonial psychotherapy has the potential to be added to the discourse, literature, theories, modalities, and practice of anti-oppression and liberation theories already in use such as “Just” Practice, Feminist theory, Empowerment practice, Ethnic sensitive practice, narrative approaches, and Mutual aid groups. Research pertaining to finding the most effective ways to create community level healing and healing between communities could extend the scope of the effectiveness of testimonial psychotherapy . (323-327)

**Narrative Exposure Therapy (NET)**

Narrative exposure therapy (NET) is a short-term trauma-focused cognitive behaviour therapy (TFCBT), for post-traumatic stress disorder (PTSD) that has been investigated in various contexts among traumatized refugees and other trauma survivors with populations from different cultural and ethnic backgrounds embedding trauma exposure in an autobiographical context.  The therapist and the patient create a timeline of the patient’s life, followed by chronologically elaborating this timeline in subsequent sessions. At the end of therapy, the patient receives the written narrative as a documented testimony. Given its focus on the lifespan, NET is particularly suited to populations affected by multiple traumatic experiences. Narrative Exposure Therapy is thought to reverse these detrimental conditions by strengthening connections to the context. With cumulative adversities and stressors, the trauma network becomes enlarged, ultimately leading to forms of trauma-related suffering : survivors are unable to contextualize cues, and thus the past becomes the present. Given the structure of traumatic memory representations, the goal of an etiologically oriented trauma therapy must be to disentangle the trauma network by assigning its hot memory elements to the respective cold memory.

Narrative Exposure Therapy (NET) starts with a checklist of both, aversive childhood experiences and threats to life across the life-span. An assessment of the individual’s mental health status follows. Then a psychoeducational introduction is presented to the survivor, focusing on the explanation of his or her disturbance and symptoms, and, if appropriate, a statement about the universality of human rights, followed by an outline of the treatment rationale tuned to the cognitive capacity of the survivor (age, formal education, etc.). NET then continues with a biographical overview of the life span. . Lifetime periods and important biographical events of the survivor are symbolized in a ritual called the lifeline. The lifeline exercise consists of placing positive and negative life events, symbolized by flowers and stones, along a “line” (e.g., cord) in chronological order. With the guidance of the therapist, the patient places the symbols next to the line while classifying them only briefly – just a label or one sentence will do. The purpose of the lifeline is the reconstruction of subjectively significant life events in their chronological order. An initial, cursory overview of the times and locations in which events occurred within the overarching context of the individual’s life, it serves as introduction to the logic of the therapeutic process. The therapist asks questions concerning the “when” and “where” an event took place, that is, focuses on cold memory and moves on before hot memory contents become strongly activated. The therapist attends to the body language of the patient. When the patient shows any signs of emotional arousal or begins to recall pictures or othersensations, the therapist remindsthe patient that a detailed processing and narration of the event will be constructed later, beginning in the next session

NET is a new treatment that has been devised specifically for the victims of organised violence, incorporating many of the exposure elements of existing models with an additional focus of clearly documenting the atrocities endured . Originally devised to be administered in refugee camps with the aim that it could meet the pragmatic demands of providing care in emergency settings by being delivered by non-mental health professionals in a short period of time, it has now being tested with asylum seekers and refugees in high-income countries. NET includes some of the components of other evidence based therapeutic approaches such as prolonged exposure with the giving of testimony to the abuses endured. as a result of the unique method of exposure and narration of the traumatic memories in NET, the traumatic experiences become embedded within the autobiographical context. The development of NET was informed by the theoretical understanding of both autobiographical memory and the framework it provides in understanding intrusive symptoms as well as how fear networks are activated in the brain the distinction between declarative ‘cold’ memory and non-declarative ‘hot’ memory Cold memory contains contextualised information about one's life at different levels of organisation, with increasingly specific information at each stage.

The first and most accessible stage contains information relating to ‘lifetime periods’, describing phases or stages in life such as where a person lived, or their occupation over a certain period The next stage contains information about ‘general events’. These can either be single or repeated events and describe what life was like at this time, such as a memory of the journey to work. Event specific knowledge is the next stage, and contains detailed contex contextual information about specific occasions such as a wedding. In addition to the contextual information stored, sensory and perceptual information (referred to as ‘hot memory’) is also linked to this event specific knowledge . ‘Hot’ memory includes detailed sensory information as well as cognitive and emotional perceptions and physiological and motor responses, all of which are intertwined. Unlike with cold memories, there is evidence that the limbic structures associated with emotion are heavily involved in sensory perceptual representations of events.

For traumatic events, these sensory perceptual representations are known as ‘fear networks’ or ‘fear structures’ The associations between the individual items within these fear networks are particularly strong, so that when an individual later encounters one external or internal stimulus within the fear network, this results in activation of the entire network. Flashbacks in PTSD are therefore thought to occur when the whole network is activated. PTSD is conceptualised as a consequence of physiological changes in the brain affecting memories that occur as a result of the noradrenergic response to stress. When stress occurs during life threatening events and subsequently in the re-experiencing , the functioning of the hippocampus is significantly impaired. Whereas the hippocampus is impaired by stress hormones, the amygdala is more intensely activated resulting in an accentuated sensory representation of the event. This disproportionate engagement of the neural structures (amygdala and hippocampus) means that memories for traumatic events differ from normal memories in that they include an increased number of cues, and the associations between cues are stronger. As a consequence of these differences, traumatic memories can be more easily activated. At the same time, reduced functioning of the hippocampus means that spatio-temporal information is not incorporated into the memory, making it very difficult for the individual to narrate the event.

 Dual representation theory (DRT) assumes that two different types of memory representation are encoded at the time of the traumatic event. One type of representation includes sensory details and affective/emotional state experienced during the traumatic event (sensory-bound representation or S-rep for short). The other includes a subset of the sensory input, recoded into an abstract structural description, along with the spatial and personal context of the person experiencing the event (contextual representation or C-rep for short). Thus, S-reps and C-reps are not primarily distinguished by the type of input (e.g. sensory versus verbal) but represent different aspects of the input that are derived from it by different types of processing. In healthy memory the S-rep and C-rep are tightly associated, such that an S-rep is generally retrieved via the associated C-rep. Access to C-reps is under voluntary control but may also occur involuntarily. According to the DRT, direct involuntary activation and re-experiencing of S-reps occurs when the S-rep is very strongly encoded, due to the extreme affective salience of the traumatic event, and the C-rep is either encoded weakly or without the usual tight association to the S-rep. This might be due to stress-induced down-regulation of the hippocampal memory system and/or due to a dissociative response to the traumatic event.Within the DRT, one aspect of therapy or normal recovery can be considered to be (re)association of the S-rep with its corresponding C-rep, so that the sensory and affective/emotional representation of the traumatic event can be seen in its appropriate context. This has beneficial consequences, such as allowing the difference between that context (the associated C-rep) and current personal context to be appreciated and used to control the retrieval of the S-rep, allowing integration with other autobiographical knowledge, and facilitating deliberate recall and communication of the details of the traumatic event.

while intrusive sensory and affective representations of a traumatic event are frequent in PTSD, consciously controlled “context-dependent” or “episodic” memories for the traumatic events are often impaired . the expression of the fearful responses is controlled by the C-rep (likely mediated by the hippocampus) so that, for example, they only occur within the same physical context in which the aversive event was experienced.

Since S-reps encode the affective and emotional states experienced, providing additional information concerning the traumatic images that increases the participant's arousal, understanding of what is being shown, personal involvement, or empathy, may strengthen the S-rep corresponding to the traumatic event.  S-reps, being sensory-bound should correspond to the egocentric image specific to the viewpoint from which the scene was perceived, whereas C-reps should correspond to a more abstract structural representation of the allocentric spatial context depicted in the scene. Processing by the hippocampus is specifically required for recognizing an object's location within a scene when tested from a shifted point of view as compared to recognizing it from the same point of view. The lack of contextual information means that the individual maintains a sense of current threat when the memory is activated and the autobiographical memory is disrupted. The individual is therefore unlikely to be able to provide a consistent chronological account of events. This theory demonstrates how repeated or multiple events are more likely to result in severe psychological disturbance. Fear networks increase and become more readily activated through repeated experiences and can also become linked to elements within the present context, such as continued threat to life or insecurity one of the aims of NET is to enhance the encoding of declarative autobiographical memory (cold memory) when hot memories are activated. This anchors the event in time and reduces the sense of current threat.

NET aims to construct a consistent autobiographical representation of traumatic events within the context of a narrative of the individual's whole life. As NET has been developed for individuals who are likely to have experienced multiple traumatic events, and as fear structures are likely to overlap, patients are not asked for the ‘worst event’. Rather they narrate all stressful life events in chronological order from birth to the present day. Individuals who are able to form a consistent narrative of individual traumatic events have been shown to benefit most from exposure therapy for PTSD suggesting that whilst habituation to the memory of the traumatic event is crucial, constructing a meaningful narrative of the event is also important in aiding recovery As more contextual autobiographical information is included into the hot memory, the fear structure is gradually inhibited, thereby reducing PTSD symptoms . Whilst the meaning of the atrocities the individual has endured remains, this process can at least provide relief in alleviating symptoms of PTSD and in accompanying the individual, step by step, through the narration and documentation of their ordeals NET is a manualised treatment .The patient first undergoes psychoeducation in which the theoretical underpinnings of PTSD and the process of NET and rationale for treatment are explained. Psychoeducation about how avoidance of reminders of traumatic events is a key feature of PTSD, and the impact of this on inhibiting treatment, is provided. Once informed consent has been obtained, the therapy can begin. Sessions are usually 60–120 min in length and ideally occur in close succession preferably with one or more sessions per week and a maximum of a fortnight between sessions. In the first session the patient constructs the ‘lifeline’. This is a physical representation of their life using a rope, beginning at birth and ending at the present day, with a section of the rope left uncoiled representing the future. The patient then briefly goes through their life, in chronological order, placing a symbol (e.g. flowers of different shapes and sizes) on the line to represent happy events and a different symbol (e.g. stones) for sad or frightening events.

The therapist's role is to ensure the correct chronology of these events. The lifeline is useful in establishing the therapeutic relationship and in providing an indication of the number of sessions that may be necessary to address all traumatic events (although some events may only be disclosed later in therapy). Following this session, subsequent sessions are dedicated to the narration of the person's life, in chronological order, with particular focus on and attention to the traumatic events. Periods between events are described in brief to contextualise the traumatic events within the individual's life and produce a coherent narrative. On approaching a traumatic incident, the focus is on contextual information, firstly establishing what life was generally like at that time (where was the person living, what were they doing, what was a typical day) and then narrowing this down as precisely as possible to what happened when the event occurred. The traumatic events are then narrated in great detail, gently resisting the patient's attempt to hurry through or avoid emotional engagement with the memory. The patient then slowly narrates their traumatic experience in chronological order, as they experienced it at the time. They are encouraged to describe all sensory modalities along with their thoughts and feelings.

The aim of NET is to connect the hot memories into the corresponding information held within the cold memory for the event and so the patient must be emotionally involved in the narration but must also put these experiences into words, constantly integrating the contextual information. At the same time as the narration of the traumatic event progresses, the patient's current physical, emotional and cognitive reactions are observed and verbalised. The therapist continually guides the patient back and forth between what is happening for the patient at the time of the narration (present time) and what occurred at the time of the event. One of the aims of the therapy is for the person to be emotionally exposed to the memory of the event for sufficient time that habituation occurs and their emotional response to the memory is diminished over the course of therapy. The session ends at a safe point in the narrative, at the end of a traumatic event, once the therapist has ensured that the patient's arousal has diminished and that their emotional state is improved. The events in the period after the traumatic incident are narrated to help the patient place the episode in context.

The narrative is written up by the therapist between sessions provides an opportunity for the therapist to ensure that they have fully understood the details and chronology of the events described and highlights areas in the story which do not seem as coherent and possibly need further exploration at the next session. At the beginning of the next session the narrative from the previous session is read to the patient to ensure accuracy, once again expose the patient to memories of the event, elicit further information and promote integration of the hot and cold memories. Usually the patient notices a reduced physiological and affective reaction from the first session, although several sessions may be necessary for habituation to occur for severely traumatic events. At the end of the re-reading of the narrative, the period between this event and the next traumatic event is briefly narrated, before moving forward to the next traumatic episode, which is again narrated in intricate detail. This process continues until all stressful events have been narrated and the affective responses to the memories have reduced. At this point, the patient and therapist will have created a testimony of the person's life from birth to the present day, with a detailed narration of the traumatic events.At the end of the therapy some time is spent discussing hopes and aspirations for the future, following which all parties who have been involved in the therapy (including the patient, therapist and interpreter) sign the completed testimony. The patient receives a copy of this for their own private records and the authors report that it is common to find patients sharing their testimonies with others including lawyers and human rights organisations

NET has been used to treat PTSD in individuals across the life span and in those who have recently experienced traumatic events as well as in those with chronic PTSD. Children constitute approximately half of the world's refugees living in low- and middle-income countries. Levels of PTSD in refugee children living in high-income countries have been found, in a systematic review of serious mental illness, to be between 11– 17% NET operates on a number of different levels, individual, micro- and macro-cultural. At an individual level it reduces distressing PTSD symptoms underpinned by cognitive and neurobiological processes, through the process of narrating and documenting the trauma endured which are contextualised within the socio-political context. In addition, it operates at a micro-cultural level by involving lay counsellors in the provision of therapy, and at a macro-cultural level by documenting human rights abuses and reducing the silence which often surrounds such painful violent events and providing a voice for the victims.A traumatic stressor (such as rape, serious injury or social exclusion) is a threat to life and/or biological fitness. During a traumatic event, information from the senses (e.g., the sound of gunshots, the smell of blood) is stored in memory, not necessarily attaining awareness. The mind and body become extremely aroused (rapid heartbeat, sweating, trembling) and are braced for actions such as hiding, fighting, or escape. The sensory elements, together with the related cognitive, emotional, and physiological responses, then form associations in memory related to the traumatic experiences.

For a new type of experience, this hot memory is connected to the contextual information, the cold memory (which has been referred to also as verbally accessible memory or contextual representation): the individual will be able to consciously remember the event and can assign it to its context, that is, where and when it has happened. For a cue of danger, it is not important to recall when and where this has been learned. Rather a rapid response is important for survival. Therefore, evolution has prearranged the organization of memory such that sensory and emotional experiences are stored in brain circuits separate from those relevant for contextual information.Following principles of associative learning, any important experience is stored in an interconnected neural network, which, for repeated adversities, may establish a “trauma network” that encompasses sensory, cognitive, and physiological representations and includes the emotional response related to the experience (hot memory). In PTSD, the hot memories have lost their association to the contextual cold memory system Environmental stimuli (e.g., a smell or noise) and internal cues (e.g., a thought) can still activate the trauma structure, but the related various times and places, when this memory has formed are not recalled. The survivor will experience this as intrusive recollection or even a “flashback,” that is, the perception that one is back in the traumatic situation with its sound of bullets, smell of fire, feeling of fear, defensive response propositions, and thoughts

Since the activation of the trauma network serves as a frightening and painful recollection, many PTSD patients learn to avoid cues that act as reminders of the traumatic event. They attempt not to think or talk about any part represented in the trauma network and to stay away from persons and places that remind them of the frightening event. In contrast to their prominent hot trauma memories, survivors who suffer from PTSD have difficulties with autobiographical cold context; that is, they are unable to orient the fear associated with the events appropriately in time and space or to clearly structure these traumatic events in chronological order . Such challenges, in conjunction with the avoidance of activating the trauma structure, make it difficult for PTSD patients to narrate their traumatic experiences . Individuals suffering from other anxiety disorders, depression, or eating disorders frequently also report repeated vivid intrusive recollections abounding in highly distressful content but lacking cold memory contextual elements the network connects to response dispositions (= emotions), which can be either an alarm response involving fight and flight or a dissociative response (up to the extent of fainting, i.e., playing dead; . Dissociative amnesia or “shutdown” can occur, replacing intrusions and hyperarousal with dissociation and passive avoidance. Both response types are evolutionarily prepared, and a patient may show either one, depending on the cues that activate the related memory.

Narrative Exposure Therapy (NET) starts with a checklist of both, aversive childhood experiences and threats to life across the life-span. An assessment of the individual’s mental health status follows. Then a psychoeducational introduction is presented to the survivor, focusing on the explanation of his or her disturbance and symptoms, and, if appropriate, a statement about the universality of human rights, followed by an outline of the treatment rationale tuned to the cognitive capacity of the survivor (age, formal education, etc.). Narrative exposure is then offered to clients with lasting and severe clinical symptoms. NET then continues with a biographical overview of the life span. Figure 12.2 schematically indicates the goal of the therapist: to determine arousal peaks across the life span. Lifetime periods and important biographical events of the survivor are symbolized in a ritual called the lifeline. The lifeline exercise consists of placing positive and negative life events, symbolized by flowers and stones, along a “line” (e.g., cord) in chronological order. With the guidance of the therapist, the patient places the symbols next to the line while classifying them only briefly – just a label or one sentence will do. The purpose of the lifeline is the reconstruction of subjectively significant life events in their chronological order. An initial, cursory overview of the times and locations in which events occurred within the overarching context of the individual’s life, it serves as introduction to the logic of the therapeutic process. The therapist asks questions concerning the “when” and “where” an event took place, that is, focuses on cold memory and moves on before hot memory contents become strongly activated. The therapist attends to the body language of the patient. When the patient shows any signs of emotional arousal or begins to recall pictures or othersensations, the therapist remindsthe patient that a detailed processing and narration of the event will be constructed later, beginning in the next session

During the narrative procedure, the survivor continues recounting his/her life story in chronological order. Wherever a “stone” (traumatic incident) occurs, the event is relived in a moment-by-moment reprocessing of the sensory, cognitive, emotional, and bodily details of the traumatic scenes, ensuring the interweaving of hot and cold memory elements, meaning-making, and integration. During the telling of the events, the therapist structures the topics and helps to clarify ambiguous descriptions. The therapist assumes an empathic and accepting role. Inconsistencies in the patient’s report are gently pointed out and often resolved by raising in-depth awareness about recurring bodily sensations or thoughts. The patient is encouraged to describe the traumatic events with sensory details and to reveal the perceptions, cognitions, and emotions that had been experienced at that time. During or after the session, the therapist either writes down a version of the patient’s narration or drafts brief notes next to the lifeline that has been sketched or photographed.In the subsequent sessions, the autobiography is briefly repeated, now emphasizing the cold memories of the event. The patient may add details that may have been missed and that he/she feels are important. Then subsequent emotionally arousing peaks (the next stones and flowers) are processed, that is, additional traumatic experiences are added to the narration. The procedure is repeated in subsequent sessions until a final version of the patient’s life span and complete biographical highlights is created. There are several options for the closing session.

The lifeline may be completed and used as review of the patient’s life. In cases where the narration has been fully recorded in written form, the document may be read aloud to the patient. The patient, the translator, if present, and the therapist sign the lifeline and/or written narration. A copy of the signed document is handed to the patient. With the agreement or upon request of the patient, another copy may be passed on to lawyers or (in anonymized form) to human rights organizations as documentation of these events. In addition, rituals can be used to ease the mourning and grief. Lastly, the patient may be counseled how to go on with life and is potentially offered further, but now future-oriented sessions (such as adjusting to a new role for a refugee or coping with relationships for a battered woman).On a personal level, successful NET treatment can lead to quite practical changes and developments in an individual’s life. While scientifically sound documentation of these changes remains a challenge, the informal evidence abounds: Former trauma inpatients go on to successfully complete job training. Go shopping in a crowded mall without panicking or fainting. Begin wearing skirts and earrings after decades of avoiding attention by hiding beneath bulky clothes. Meet friends at a public café after years of isolation. Establish a romantic relationship. Or even simply apply lotion to their body without feelings of disgust. Survivors may be able to experience moments of sudden joy again (328-329)

**Eye movement desensitization and reprocessing (EMDR)** **therapy**

Eye movement desensitization and reprocessing (EMDR) is an empirically validated psychotherapy approach that medical personnel can employ to treat the sequelae of psychological trauma and other negative life experiences. Clinical applications of EMDR include a wide variety of psychological problems affecting patients and family members, as well as stress-induced physical disorders and medically unexplained symptoms.

EMDR therapy aims to reduce subjective distress and strengthen adaptive cognitions related to the traumatic event. EMDR does not involve

a) detailed descriptions of the event,

b) direct challenging of beliefs,

c) extended exposure, or

d) homework.”

EMDR therapy is used to support family members dealing with the death of a loved one. The results of both prolonged debilitation and sudden death can involve trauma symptoms that include distressing intrusive images of the suffering patient. The family member is unable to retrieve positive memories of the deceased, which further exacerbates and complicates the grieving process. (330-331)

**CASES OF MIND-BODY MEDICINE**

CAM (complementary alternative medicine) can be divided into four types of treatment:

(1) traditional Asian medical systems (TAMS), including traditional Chinese medicine, acupuncture, and acupressure;

(2) alternative medicinal systems (AMS), including homeopathy and herbal therapy;

(3) manual body-based therapies (MBBTs), including massage therapy, chiropractic therapy, osteopathy, and reflexology; and

(4) mind-body therapies (MBTs), including hypnotherapy and psychotherapy .

**General pain.** Pain syndromes are the most com monly studied neurologic condition to which mind–body therapies are applied. Mind–body therapies including hypnosis and meditation may improve general pain symptoms and lessen the need for anesthetics. Hypnosis for analgesia is of ten superior to other non-pharmacologic treat ments for producing changes in pain reports. Also, patients undergoing surgery with hypnosis need significantly less chemical analgesia. A mechanism for analgesic hypnosis has been dem onstrated in a PET study revealing significant changes in pain-evoked activity within the ante rior cingulate cortex consistent with the encoding of perceived unpleasantness, whereas the primary somatosensory cortex activation was unaltered.

**Back pain, neck pain, and carpal tunnel syndrome.** Some specific pain syndromes may also benefit from mind–body interventions. Chronic back pain has been successfully treated using various mind–body techniques such as breathing tech niques, relaxation training, therapeutic eu rythmy, and yoga.

**Headaches.** Chronic tension and mixed type head aches appear to benefit from mind–body inter ventions. Clinical trials for chronic tension-type headaches have found that relaxation training significantly reduced headache activity compared to talk therapy, self-monitoring, muscle relaxant (chlormezanone), information/education, and no treatment.

**Fibromyalgia.** Studies of mind–body interventions for fibromyalgia have been inconclusive. In a sys tematic review, mind–body therapy was found more effective for clinical outcomes compared to waiting list/treatment as usual or other control groups. (332)

**Multiple sclerosis.** Research in mind–body medicine has shown 33–65% of patients with multiple sclerosis use CAM. (333)

**Epilepsy.** Biofeedback, relaxation, yoga, and com prehensive behavioral approaches have been used to treat epilepsy with varying results. EEG biofeedback techniques for epilepsy are based on observations that several components of the EEG can be modified by training to increase the mu or sensorimotor rhythm, or low-frequency com ponents termed “slow cortical potentials” or “DC-shift” which may be similar to a mental relaxation procedure.

Hyperventilation such as in anxiety is a common trigger for generalized forms of epilepsy. Relaxed diaphragmatic breathing may reverse this effect by increasing pCO2 and thus increas ing seizure threshold.38 Deep breathing is often a component of biofeedback, meditation, and relaxation training, and the increase in pCO2 may be one mechanism of action. Voluntary hyperventilation triggers seizures in the vast majority of people with [absence epilepsy](https://www.sciencedirect.com/topics/neuroscience/epileptic-absence).The most promising mind–body approaches for control of epileptic seizures appear to be com prehensive behavioral programs, which may in clude lifestyle modification, aura interruption techniques, and meditative relaxation. (334-335)

**Muscular dysfunction.** A few biofeedback studies for pelvic floor dysfunction reveal clinical im provement. EMG biofeedback and neuromuscu lar stimulation included in pelvic floor muscle training for bladder dysfunction enhanced blad der function. A systematic review examining the efficacy of biofeedback treatment for various ano rectal smooth muscle dysfunctions reported that biofeedback success rate was significantly higher for pelvic floor dyssynergia and fecal incontinence when compared to standard medical care. There has been a fair amount of mind body research on risk factors for stroke, espe cially for hypertension. There is some evidence that mild reductions in blood pressure can be achieved with meditation or breathing exercises. A single exploratory study demonstrated changes in carotid artery intimal thickness. (336)

**Aging**. Aging has been considered a progressive decrease of a living organism's homeodynamics, which indicates a reduction of psycho-biological resilience. Tai chi seems to have asignificant effect on reducing the incidence of falls and fall injuries, fear of falling, balance, and overall health in the elderly. This finding is especially true for the pre frail elderly or people with lower levels of base line physical function. Tai chi also seems to have an overall beneficial effect in “physical function ing” in older adults (65 to 96 years old) even de creasing daytime sleepiness. (337)

**Parkinson’s disease (PD).** . is a neurodegenerative movement disorder characterized by a range of motor symptoms, including resting tremor, rigidity, bradykinesia, and postural instability and various non-motor symptoms (NMSs), such as cognitive impairment, sleep disorders, fatigue, depression, anxiety, apathy, olfactory deficit, and constipation, at any stage of the disease, including early and premotor phases, finally leading to disability . Cognitive and psychiatric symptoms are the major non-motor features of PD . Within 5 years of diagnosis, 25–50% of patients with PD develop to mild cognitive impairment (MCI) or dementia

The conventional treatment for PD is pharmacotherapy based on dopamine replacement. As the disease progresses, an increasing dosage of pharmacotherapy and drugs are usually ineffective, but simultaneously may cause side effects and limit physical and daily activities . Moreover, many NMSs of PD are unresponsive to conventional pharmacotherapy.

The National Center for Complementary and Alternative Medicine states that mind–body medicine is based on the interplay among the brain, mind, body, and behavior, as well as the powerful ways in which emotional, psychological, social, spiritual, and behavioral factors directly affect human health. Mind–body medicine focuses on respecting and enhancing each person’s self-knowledge and self-care abilities as a basic approach Mind–body exercise as a non-pharmacological therapy has received increasing attention.

Tai Chi and Qigong, two forms of traditional Chinese exercises, combine body movements, breathing and mental training to maintain health and eliminate disease syndromes. Tai Chi has been found beneficial for specific diseases, such as PD, cognitive disorder, dementia, and depression, and focus on the potential mechanisms of Tai Chi in modulating brain morphology, functional homogeneity, activity, and connectivity changes in the cognitive potential P300 . observed are observed before and after Qigong therapy as an adjuvant to clinical treatment and N2 and P3 latent periods of ERPs in patients with PD were significantly shortened after Qigong exercise, reflecting improvements in the cognitive processes of attention control and processing ability, which confirmed the efficacy of Qigong exercise as a supplementary treatment to PD

**Depression-anxiety.**

Mindfulness MMBCEP is an integrative program that combines mindfulness stress reduction (MBSR) with the senior fitness test manual, which alleviate depression and anxiety, eliminates negative thought and relax, and subsequently exerting beneficial effects on sleep. (338).

**Attention deficit hyperactivity disorder (ADHD**) , which is a neurodevelopmental disorder characterized by troubles with inattention, distractibility, emotional dysregulation, hyperactivity and/or impulsivity inconsistent with age. ADHD starts in childhood and results in dysfunctional social, academic and occupational environments that continue into adulthood. Attention deficit hyperactivity disorder (ADHD) is a chronic and potentially handicapping developmental disorder that affects and persist throughout life in both 5% of children and 4% adults.

Children are at risk for a range of problems including low self-esteem, peer rejection, physical injuries and poor adaptive functioning. The symptom presentation of ADHD differs across the lifespan.While hyperactivity declines over time, inattention and executive function difficulties persist, leading to functional deficits. As individuals reach adolescence, the hyperactivity tends to abate somewhat while the inattention persists and often becomes more disabling Adolescents and adults with ADHD have significant difficulties in academics, work and life skills, such as driving and parenting and focusing during lectures or while reading and listening and following through on instructions or finishing tasks with executive function and behavioral inhibition and pervasive impairment in interpersonal and family relationships.they complain of their mind “wandering”. They tend to make decisions impulsively and high rates of substance use, unemployment, divorce, antisocial behaviors and psychiatric comorbidities since they are prone to use alcohol, tobacco and other substances and develop addiction, delinquent behavior and comorbid psychiatric disorders. In adolescence, impulsivity presents as recklessness, unpremeditated actions and impatience. the characteristic rambunctiousness of children with ADHD recedes and is replaced by motor restlessness. Adolescents with ADHD report feeling on edge and often choose activities that are physical in nature in order to avoid sedentary tasks. Inattention is manifested by distractibility, carelessness, forgetfulness and organizational difficulty. They frequently lose or misplace items and characteristically work in cluttered and disorganized environments. They avoid activities that require prolonged attention. The difficulty with sustaining attention leads to marked school difficulties. Struggles with studying or paying attention in class can lead to academic decline and failure Adults run the risk of unemployment due to ADHD jeopardizing job performance and acceptable attendance records. Socially, relationships with others are threatened as inattention is seen as laziness, irresponsibility and unwillingness to cooperate

Neurobiological research has tied ADHD symptoms to structural-functional brain abnormalities and delayed development of the neocortex. As children develop, brain maturation progresses in a posteroanterior fashion. Initially, myelination takes place in the visual pathway and then progresses to anterior areas such as the dysfunction of the prefrontal cortex (PFC) and fronto-striatal circuitry in ADHD, The brain development that occurs during adolescence primarily involves changes in the frontal and parietal cortices, the sites responsible for executive function. A peak in gray matter volume at puberty is followed by a gradual decline, as the cortex undergoes synaptic pruning in areas that play a role in impulse control, planning and emotion regulation. The evolutional path of the brain in children with ADHD follows a parallel course with controls, but always with significantly smaller gray matter volumes.

Traditional magnetic resonance imaging (MRI) studies in children with ADHD have shown reduced volume in the frontal cortex, anterior cingulate cortex (ACC), basal ganglia and cerebellum as well as in adults with ADHD overall reductions in cortical gray matter volume in the ACC, orbitofrontal cortex (OFC), inferior frontal cortex, dorsolateral prefrontal cortex (DLPFC), temporoparietal, cerebellar and occipital regions and volumetric reductions in subcortical areas. The ACC, which modulates the peripheral nervous system (PNS) and the central locus ceruleus (LC), both norepinephrine (NE)-driven systems, is activated by novel or salient stimuli as part of a neural circuit that serves to regulate cognitive and emotional processing.

By rapidly modulating the activity levels of both principal NE systems, the ACC is able to adapt the state of the whole organism to optimize attention and support complex behavior. It is also responsible for selective attention and conflict monitoring. The ACC is the primary structure responsible for salience and detection of executive PFC networks, that integrate input from the internal and external environments to maximize adaptive processes.

The PFC provides top-down (cerebral-to-limbic) regulation of attention and behavioral inhibition through connections with posterior cortical and subcortical structures. The OFC is involved in decision-making and impulsivity. The function of the DLPFC is to sustain attention, problem solve and organize information and activate the brain mechanisms necessary for working memory and task completion. PFC structures act in concert as well as communicate with subcortical structures (*e.g*., basal ganglia, cerebellum) to optimize attention and executive function. The catecholamine neurotransmitters, dopamine and NE, are critical for communication between the PFC and other brain structures. Concentrations of these neurotransmitters in the PFC follow a bimodal curve: too much or too little disrupts its functioning. In persons afflicted with ADHD, poor connectivity among these brain areas may underlie the pathology associated with impaired goal setting, organization and planning. Functional MRI (fMRI) findings have suggested that individuals with ADHD have hypoactivity in the PFC areas, superior parietal areas, caudate nucleus and thalamus. The literature indicates that ADHD is characterized by multiple functional and structural neural network abnormalities beyond the classical fronto-striatal model, including fronto-parietal-temporal, fronto-cerebellar and even fronto-limbic networks. Evidence suggests that certain meditative practices that improve attention ameliorate the symptoms of ADHD by activating brain regions implicated in both sustaining and directing attention. Mindfulness derived from Eastern meditation practices, has been defined as “bringing one’s complete attention to experience the present moment and improves self-regulation of attention and increases ability to suppress task-unrelated thoughts and distractions resulting in improved attention, completion of tasks and potential improvement in occupational and social function. Its basic elements are intention, attitude and attention. The ability to direct one’s attention can be developed through the practice of intentional self-regulation of attention from moment to moment.

Mindfulness has been conceptualized as a fundamental way of being, through a learned skill involving non-judgmental observation of thoughts, emotions and somatic sensations that arise in one’s awareness. Two types of meditation are broadly recognized: focused and receptive attention. Focused or concentrative meditation entails focusing on a specific thought, such as an image or body sensation, while distracting events are disregarded. This allows the meditator to concentrate on one thing at a time rather than allowing attention to split among tasks. One example is the mindfulness of breathing, where a participant is trained to focus on his/her breathing and sustain attention on this sensation for the practice duration. The training includes explicit instructions to notice mind wandering and respond by redirecting attention. If the participant notices his/her attention wander away from the breath, he or she must notice the drift in attention and return to the breath. This practice leads to less distractibility and better ability to stay on task.Another type of meditation, called open monitoring or receptive attention, includes observing the content of one’s experience (*e.g*., sensations, thoughts and emotions) from moment to moment without reacting. In the open monitoring meditation, attention is extended to the whole field of awareness. It involves being alert to any stimuli that arise in the moment rather than a steady focus on one specific object. This type of meditation enhances attention switching, the ability to purposefully shift the attention focus between stimuli. By directing attention to the experience of the moment, subjects learn to identify and dismiss unhelpful automatic reactions. This improvement in receptive attention can improve self-regulation and impulse control and task completion. The alerting network attains and sustains a state of vigilance and is subserved by the reticular activating system. The orienting subsystem involves the parietal lobe. Its function is to select relevant environmental information and enable one to react quickly to a situation.EEGneurofeedback has been widely used as a nonpharmacologic treatment in children and adults with ADHD . The rationale for neurofeedback comes from operant conditioning studies in humans that demonstrated capacity for neurophysiologic training. Neurofeedback at tempts to regulate the atypical patterns of cortical activation identified in neuroimaging and quanti tative EEG studies in people diagnosed with ADHD. (339)

**Anger** is a widely prevalent emotional problem that has been linked to both physical and mental disease and associated with increased risk for stroke , myocardial infarction , hypertension and cardiovascular mortality, depression, substance abuse and physical aggression . Treatment strategies have focused on anger as the primary problem and comorbid with other psychological disorders, typically depression and anxiety. The treatment of anger has included CBT, CT, relaxation, skills training, and multicomponent interventions. (340)

**Placebo effects**. Clinical studies of mind–body therapies are inherently more difficult than drug studies because of the absence of blinding of the participant. Biofeedback is one of the few mind body interventions that can potentially be blinded through the use of sham feedback.Thus, pla cebo or expectancy effects which have a signifi cant impact in many disorders are especially difficult to control for in mind–body clinical tri als. The potential benefit of a treatment in which the patient actively participates may be due to increased self-efficacy, the person’s sense of ability to deal with a situation which, by itself, is associated with physiologic benefits.49 Clinical trials try to address these issues by advancing be yondwait-list controls to attention or other active controls (e.g., education with homework). The expectancy of improvement from mind–body in terventions needs to be assessed in clinical trials. The beneficial effect of mind–body techniques likely represents a sum of these nonspecific effects (expectancy and self-efficacy) and the actual physiologic benefit of the mind–body practice.

The repeated practice of the exercises increases the person’s capacity to induce ever-deeper relaxation and fosters the accumulation of therapeutic benefits. Implementation of safe and effective mind–body therapies, (relaxation, stress management,biofeedback) as an essential part of a practical, holistic, integrative approach for an array of health-related problems, such as chronic low back pain,headache, insomnia, cardiac rehabilitation(prevention of postinfarction morbidity/mortality), management of diseaserelated symptoms in cancer,osteoarthritis, rheumatoid arthritis, and postsurgical outcomes, and treatment of hypertension give the following potential benefits:

• Promotion of self-efficacy and self-directed empowering

• Patient-centered care for significant cost savings

• and reduced utilization of health care services

• Improvement in function and quality of life

• Patient satisfaction

• Early return to work,

• Better health outcomes

## Results from functional genomics and neuroimaging describe the processes involved in the mind-body connection and how they influence health outcomes The scope of mind-body therapies (MBTs) include meditation, yoga, guided imagery, breathing exercises, progressive relaxation, Tai Chi Chuan, etc. MBTs can enhance health outcomes, act as effective adjuncts to conventional medical treatment and be integrated into an evolving mainstream medical paradigm referred to as “Integrative Medicine”. Mind–body therapies, or MBTs, have been defined as a group of therapies that emphasize use of the brain in conjunction with the body to assist the healing process . These therapies, the majority of which are based on ancient practices and traditions, are believed to have beneficial effects on mental and physical health and are widely used to manage symptoms and improve well-being. Developments in psychosocial genomics have demonstrated the relevance of psychosocial factors in gene expression and identified some underlying processes, such as sympathetic nervous system activation of gene transcription factors.

A related mechanism by which MBTs may modulate the immune system is via the cholinergic anti-inflammatory pathway . The vagus nerve complex forms a bi-directional neural connection between the immune and nervous systems which acts to regulate inflammation and innate immune responses during tissue injury and pathogen invasion . Efferent vagal signaling from prefrontal cortex and amyg dala can inhibit cytokine production via acetylcholine receptor signaling in the spleen . Conversely, afferent vagal signaling is reflected in instantaneous heart rate variability. Depressed vagus nerve activity is associated with increased morbidity and mortality in sepsis, rheumatoid arthritis, lupus, sarcoidosis, inflammatory bowel diseases, trauma , depression and stress . Enhanced vagal tone is associated with a variety of benefits, including increased social and psychological well-being and has been suggested as a neurological basis for the effects of acupuncture and meditation .Another means by which MBTs impact the body is through influencing the activity of the nervous system, or neuromodulation. Neuromodulation via MBTs is supported by studies demonstrating that particular MBTs can elicit characteristic patterns of brain activity, including increased activity in specific brain regions and specific changes in connectivity. Such a viewpoint is in accord with the notion that meditation can stimulate cortical plasticity and produce changes in neural structures associated with cognitive restructuring and learning, and is supported by the broader view that cognitive interventions can exert their effects on brain and behavioral development through neuromodulatory mechanisms involving plasticity. Mind body therapies (MBT) are a group of therapies based on psychosomatic medicine, which emphasizes the combined use of the brain and body, and a variety of therapies to promote physical and mental health. these therapies are mostly based on ancient practices such as yoga, tai chi, meditation, and acupuncture, and have similar concepts and applications to MBT in traditional medicine in different regions.

Contemporary MBT encompass three core modalities:

(1) Cognitive Optimization Therapies (e.g., meditation, positive psychology), utilizing neuroplasticity-enhancing training to improve executive function through cognitive reframing and attentional control;

(2) Dynamic Somatic Therapies (yoga, tai chi, qigong), achieving psychophysiological equilibrium via biomechanical alignment and synchronized breath-energy modulation;

(3) Deep Relaxation Modalities (breathwork, hypnotherapy), attenuating stress biomarkers through targeted parasympathetic nervous system activation. Meditation is used to improve an individual’s core mental abilities through mental exercises such as those related to attention and emotional self-regulation. These exercises lead to neuroplastic changes in the structure and function of brain regions involved in the regulation of attention, emotion, and self-awareness . Therapies such as yoga and qigong are used to improve physical and mental health and quality of life (QoL) by combining muscular activity, respiratory regulation, and the training of concentration.

Positive psychology is considered an interdisciplinary field linking psychology and neuroscience, which combines humanistic philosophy with the principles of neuroplasticity to improve cognition and thus increase positive feelings and behaviors. This means that the application of positive psychology can not only be used for disease intervention, but also improve people’s mental toughness, promote mental health, adjust physical and mental state, and prevent disease. In addition, therapies such as acupuncture and Chinese herbal medicine, which are mind-body regulating therapies that are based on the theories of traditional Chinese medicine, can directly or indirectly adjust the patient’s physical and mental state and relieve the patient’s pain and perceived stress . A study in the United States showed that 17–20% of adults participated in the practice of MBT. Increasingly, healthy people or patients are using MBT to promote their health or to improve their clinical symptoms.

With the rapid advancement of science and technology, medical research continues to advance. Psychosocial factors, such as anxiety, depression, and psychosocial stress, can directly affect the body’s physiological functioning and health outcomes, and the body’s discomfort also has a direct impact on psychological states. MBT are specific treatments under the the Biopsychosocial Model (BPSM), as a form of complementary and alternative medicine, can achieve medical cures. There are a wealth of research demonstrating the significant positive impact of a variety of mind-body therapies in treating coronary artery disease, headaches, insomnia, incontinence, chronic low back pain, cancer, and other disorders in terms of therapeutic efficacy and improved post-surgical outcomes. Researchers have gained a deeper understanding of the neurobiological, physiological, and genomic changes associated with MBT, including activation of specific brain regions, increased heart rate variability, inhibition of stress-induced inflammatory pathways, and increased telomerase expression MBT have the advantages of clinical urgency, easy public access, relatively high social acceptance, and low cost, and can play a dominant role in many disorders, especially when interventions such as drugs are not appropriate. Altered inflammatory processes are thought to be responsible for the role of many mind-body therapies in pathologies, including fatigue, depression, pain, and heart disease. Mind-body therapies such as tai chi, qigong, meditation, and yoga interventions can have an impact on inflammatory cytokine activity. Mind-body therapies have been shown to reduce inflammatory markers, decrease inflammatory gene expression, and decrease pro-inflammatory transcription factor nuclear factor NF-jB activity.

MBT have been globally proven to be effective in a wide range of disease interventions, and incorporated into health services, in the intervention of chronic diseases, anxiety and depression, and cancer. Mind/body therapies, such as yoga, mindfulness, and guided imagery, slow cognitive decline, improve brain health, and ameliorate negative psychological symptoms such as stress and depression.  Microbiota profiles, which are dependent upon lifestyle factors, can facilitate physical and mental well-being via MBT practices. Mind–body therapies that empower the patient and promote patient-centered care associated with improved patient satisfaction, better health outcomes and state of health, as well as reduced utilization of health care services. The implementation of mind–body therapies can realize immediate and significant cost savings. Implementation of safe and effective mind–body therapies, as an essential part of a practical, holistic, integrative approach to the management of chronic pain as an example , give potential benefits such as promotion of self-efficacy, relative low cost, ability to be self-directed, decreased use of other clinical support systems, improvement in function, return to work, quality of life, and decrements in use of opioids and polypharmacy approaches to care. Medicine must shift from an exclusively “biomedical” model to “biopsychosocial” understanding of health and illness. “Mind-body therapies” (MBTs)(eg, relaxation, stress management, meditation, biofeedback) can be effective adjunctive treatments for an array of health-related problems, in the areas of chronic low backpain, headache disorders, insomnia, prevention of postinfarction morbidity/mortality,management of treatment and disease-related symptoms in cancer, osteoarthritis, rheumatoid arthritis, and postsurgical outcomes, and the treatment of hypertension.

Searching the focus groups with physicians, medical students, and residents, the following factors have appeared as possible barriers to the integration of mind-body principles and practices in medicine

1. Lack of scientific evidence about efficacy of mind-body/ psychosocial approaches;

2. Inadequate attention to psychosocial factors and dehumanizing aspects of medical education;

3. Tendency to reduce psychosocial factors against biological/ biochemical processes;

4. Creating a division between conditions perceived purely biological in etiology and psychological in nature;

5. Feelings of inadequacy to utilize mind-body interventions and lack of awareness of resources to refer ;

6. Lack of time to address psychosocial/mind-body issues;

7. Lack of third-party reimbursement for mind-body issues in medical encounter;

8. Belief that spending large amounts of time with patients addressing the psychosocial domain is not economically practical

9. Perception that psychosocial issues are beyond the immediate control;

10. Concern that more serious, life-threatening, biological aspects of patients might be underemphasized if too much weight or attention is given to psychosocial domain.

11. Lack of interest or motivation of patients to address psychosocial/lifestyle issues (eg, preference for “quickfix” and symptom relief offered by more conventional, pharmacological approaches);

12. Belief(or larger culture’s perception) that physicians are not trained to address interior lives of patients

13. Fear that patients might feel stigmatized if physicians suggest that psychosocial/mind-body factors play causal role in their symptoms . (341-345)

**QUANTUM MECHANİCS**

There is a solid growth of quantum theory in that there is quantum physics, quantum chemistry, quantum biology, and a robust technology based on quantum behaviors and effects-to name but the most solid examples of the development and enhancement of quantum science. Quantum science is by and large the most robust theory, ever.  Conventional science and quantum physics represent two different perceptions and explanations of reality. The conventional biomolecular framework assumes that biocommunication in living systems operates primarily from chemically mediated interactions. The emergence of quantum physics has led to new models for understanding subatomic interactions. Quantum field theory introduces the concept of a field as a space-filling primary entity that creates, connects, and destroys particles. Researchers are finding evidence that quantum theory provides the most accurate model of physical reality and that the underlying principles may be useful in a healing context. Quantum theory has significant implications for understanding the relationship between consciousness and human health. Increasingly, quantum physics–inspired models are proposed to describe a wide variety of psychological and physiological processes that have been difficult to explain through traditional assumptions.

Clinician awareness of the application of quantum theory to human health and interactions has the potential to enhance relationships, trust, and open communication to facilitate an integrative approach to patient care since the bidirectional flow of energy in humans has implications for health as well as for communication between individuals. Energetic phenomena in humans may be understood through quantum physics principles. Concepts from quantum physics can be applied to describe information transfer and dynamic relationships within the human system. The bioenergetic aspects of human physiology include molecular energy fields in and between cells and their interactions with other energy fields. Information exchange is vital to all living systems whether the communication is inter- or intra-cellular, organ to organ, brain to body, or individual to individual. Experimental evidence support that some aspects of human cognitive abilities impacting communication such as intuitive judgment and awareness of context, are better explained using quantum rather than classical models. Quantum physics transcends conventional notions of signaling and information transfer. (346-347)

Examples of quantum information theory principles applied to human being are as follows:

**Nonlocality:** According to quantum theory, nonlocality is a fundamental aspect of reality. The principle of nonlocality is the potential remote relationship between separate particles regardless of how large or small is the system.  This principle states that regardless of how large or small a system is, one part can [affect](https://www.sciencedirect.com/topics/medicine-and-dentistry/affect) the whole system concurrently and without direct connectivity. Nonlocal influences don’t diminish with distance, by known form of exchanged energy. The principle of nonlocality can be applied to explore distant healing and prayer between individuals across space and time. While this principle initially was thought only to apply to microscopic particles, recent advances in research have shown that also occurs in macroscopic systems. [Experimental research](https://www.sciencedirect.com/topics/nursing-and-health-professions/experimental-research)  results have demonstrated that nonlocal brain-to-brain correlation, support the brain׳s quantum nature at the macroscopic level. Nonlocality may underlie bioenergetic aspects of human biology and can explain how the mind–body connection is impacted by intuition and intention. Quantum theory has reached the point where the source of all matter and energy is nothingness containing all the possibilities of everything that have ever existed or could exist.

The visual agnosic patient is not able to tell what he is looking at, although it can be demonstrated that the patient can see the object. Prosopagnosic patients, that are neither blind nor intellectually impaired, can interpret facial expressions and recognize their friends and relations by name or voice, yet they do not recognize specific faces, not even their own in a mirror. To compensate for their deficit, patients use their other senses and cues such as voice, shapes, and anomalous contours of the face, but these compensatory mechanisms, at times, may not be enough to recognize familiar faces. This impairment causes a psychological and social impact leading to functional impairment, unemployment, social isolation, depression, anxiety, and other mood disorders

Prosopagnosia is defined as the inability to recognize known and new faces as facial/visual agnosia.  The word comes from Greek *prosopon,* meaning face and *agnosia,* meaning lack of knowledge. Normally, an individual can recognize and remember 5000+ faces throughout their lifetime. Peculiarly, patients complain of having trouble following television shows and movies because they cannot visually keep track of characters. Electrodermal recordings show that the prosopagnosic patients respond and react to familiar faces without awareness, but subconsciously register their significance. Variants of prosopagnosia include an apperceptive variant (deficits in facial structure perception), and amnestic or associative variant (unable to remember faces even though they can perceive them; the perceptual information can not access facial memories because of a disconnection or loss of them).

Visual information is first received in the V1-2 visual cortex. This information then travels to the V3-5 visual association cortex. Both a ventral and dorsal stream are necessary to further interpret “what” is seen and “where” it is seen, respectively. Facial recognition is processed in the inferior occipital lobe at the fusiform gyrus, where communication occurs with the temporal lobe to associate with memory and apply meaning to the face When there is a lesion that occurs at some level of this processing, the patient complains of prosopagnosia. Usually lesions are in the bilateral inferior occipitotemporal lobes. (348-351)

**Entanglement**:

‘Entanglement’ is a genuine quantum phenomenon, in the sense that it has no counter- part in classical physics. It was originally identifed in quantum physics experiments by considering composite entities made up of two (or more) sub-entities which have interacted in the past but are now sufciently distant from each other. If joint measurements are performed on the sub-entities when the composite entity is in an ‘entangled state’, then the sub-entities exhibit, despite their spatial separation, statistical correlations which cannot be represented in the formalism of classical physics. A growing amount of research has been devoted to identify quantum ntheoretic structures, including entanglement, in non-physical domains, such as cognition, biology, ecology, computer and social sciences . The reason for the appearance of quantum-theoretic structures in these domains, however, has not to be searched in that nature is fundamentally made up of quantum entities at the micro-level but, rather, in that the entities studied in these domains exhibit aspects, when they interact with each other and with an external context, which makes the mathematical formalism(s) of quantum theory more suited than more traditional classical formalisms to represent them, their properties, their states and state transformations, their measurements and measurement statistics.

The principle of entanglement refers to how objects that appear separate are actually interconnected even though their spacial distance would exclude this as a possibility. Microscopic particles that have been in contact with one another and become entangled can be observed at a distance as mirroring and providing information about the other׳s movement or spin. The interacting individual particles can no longer be considered separate regardless of distance. Molecules are sensitive to magnetic fields because of electron entanglement. Quantum entanglement has been correlated to DNA oscillations and transmission of information within thebody. Magnetic resonance imaging(MRI) scans of recipients receiving distant healing have shown changes in the frontal lobe of the brain, supporting evidence of macroscopic entanglement. The well-documented psychophysiological impact of the placebo effect has also been associated with the principle of entanglement.

Quantum entanglement, is a mechanical phenomenon at the quantum level wherein the quantum states of two or more particles become codependent, with the properties of one being instantaneously affected by measurements conducted on the other and are described with reference to each other though these particles may be spatially separated. Entangled systems need special preparation, e.g., a pair of electrons having opposite spins, has to be created, with the actual spin of each particle remaining in a state of quantum uncertainty (a situation described as “entanglement of the “wavefunction”).” On the separation of the pair of particles, even by a huge distance, and on measuring one particle’s spin the other particle’s spin will automatically resolve itself in the other direction. This effect occurs instantaneously, apparently breaching the velocity of light and the rules of relativity, referred to as “spooky action at a distance”.

In quantum teleportation, a pair of entangled particles are used to transmit information about a third object instantaneously from one place to another. The original particle with information to be teleported is scanned. The scanning process disrupts the original particle and modifies both the entangled particles, which are separated by a large distance, instantaneously. The treatment process recreates the properties of the original particle. A “teleported” replica is thus formed. Though transmitting human atoms (human teleportation) is not possible yet, information can be transmitted across space by using quantum teleportation. For instance, two persons each holding one of a pair of entangled particles could use them to convey qubits by making particular measurements. These two persons have to first acquire a pair of entangled particles, e.g., two entangled photons, each of them taking one photon away. One person’s qubit might be in some state that he wants to send to the other person. Even if the former does not know what that state is, he could make the other person’s photon give him that message. The former destroys his photon when he makes a measurement of the photon. However, the other person’s photon now takes over and the other person extracts the information by making his own measurement. Entangled particles could also be used to send coded messages allowing only the intended receiver to read them. The universe appears to be one large quantum connection system connections with innumerable particles speaking to their distant twins.Two identical particles being in a superposition of two quantum states in one process are entangled and remain so even if separated by long distances. If one checks on one’s measurement immediately affects the quantum state of the other particle. Particles could be in more than one state simultaneously and the probability wave which predicts their position enables them to act as though they were in more than one place.

Quantum entanglement may also be a case of nonlocality. What happens in one place depends on what happens elsewhere. As an example for a light switch that controls two or more light bulbs, when the light switch is turned on the two or more light bulbs are lighted simultaneously. When two subatomic particles (for instance protons or neutrons) get extremely close (so close that they start behaving quantum mechanically), the wave function of each splits and disturbs the probability density of the other, causing it in turn to split, ad infinitum. When two atoms travelling at nearly colliding head on, it is possible for one to knock off the outer electron of the next atom in the line leaving the nucleus exposed fast enough within a femtosecond (10−15 s) after the collision took place, the resulting change of the wave function will affect not simply both atoms and the entire surrounding environment in terms of the final result but will in addition cause the initial conditions of the two original atoms to alter. This means that the disturbance caused by each one passes through the entire Universe in a flash of light. The Singularity depends crucially upon the strength of coupling of one particular kind of field (gravitational radiation for instance).

The behavior of qubits relates directly to the behavior of a spinning electron orbiting an atom’s nucleus, which can demonstrate three key quantum properties: quantum superposition, quantum entanglement, and quantum interference. Quantum superposition refers to the fact that a spinning electron’s position cannot be pinpointed to any specific location at any time, but can be calculated as a probability distribution in which the electron can exist at all locations at all times with varying probabilities. Quantum computers rely on quantum superposition and use a group of qubits for calculations and, while classical computer bits may take on only states 0 and 1, qubits can be either a 0 or 1, or a linear combination of both. These linear combinations are termed superposition states. Since a qubit can exist in two states, the computing capacity of a qubit quantum computer grows exponentially in the form of 2q. Quantumentanglement takes place in a highly intertwined pair of systems, such that knowledge of anyone immediately provides information about the other, regardless of the distance between them. This nonintuitive factdescribed as “spooky action at a distance”, went against the rule that information could never be communicated beyond light speed. When two systems such as photon or electrons are so highly interlinked, obtaining information about one’s state (for example, the direction of one electron’s upward spin) would provide instantaneous information about the other’s state, such as, the direction of the second electron’s downward spin, no matter how far apart they are. Modifying one entangled qubit’s state immediately perturbs the paired qubit’s state in quantum computers.

Entanglement leads to the increased computational efficiency of quantum computers. Processing one qubit providing the knowledge about many qubits, does not mean that doubling the number of qubits does increase the number of entangled qubits. Quantum entanglement is necessary for the exponentially faster performance of a quantum algorithm as compared with its classical counterpart. Quantum interference occurs at the subatomic scale. The wavelike properties of particles are attributed to location, where around a nucleus an electron might be. Two in-phase waves, which peak at the same time, constructively interfere, and the resulting wave peaks twice as high. Two waves that are out-of-phase, peak at opposite times and destructively interfere; the resulting wave is completely flat. All other phase differences will result somewhere in between a higher peak for constructive interference or a lower peak for destructive interference. In quantum computing, interference affects probability amplitudes in measuring the energy level of qubits. Quantum computing has applications in various disciplines, including communication, image processing, information theory, electronics, cryptography, etc.The principle of entanglement tells that separate objects are actually interconnected eventhough their spacial distance excludes this possibility. Entangled microscopic particles in contact with one another can be observed at a distance as mirroring and providing information about the other׳s movement or spin. When individual particles interact, a new property of the multi-particle system emerges that can no longer be considered separate—regardless of distance.

 Molecules are sensitive to magnetic fields because of electron entanglement. Quantum entanglement has been correlated to DNA oscillations and transmission of information within the body.  [Magnetic resonance imaging](https://www.sciencedirect.com/topics/medicine-and-dentistry/magnetic-resonance-imaging)(MRI) scans of recipients receiving distant healing have shown changes in the [frontal lobe](https://www.sciencedirect.com/topics/medicine-and-dentistry/frontal-lobe) of the brain, supporting evidence of macroscopic entanglement. In addition, the well-documented psycho-physiological impact of the placebo effect has also been associated with the principle of entanglement.The psycho-physiological impact and neurophysiological effect are associated with the principle of entanglement. Belief and positive expectation can modify the stress response and lead to placebo responsiveness of many psychophysiological disorders such as hypertension, angina, inflammatory bowel disease, and asthma. The acute affective benefits of exercise (and other passive treatments) depend of the mental interpretation of the activity in which the participant is engaged, since the engagement in a pleasant activity yields positive effects. All life experiences perceived as pleasant or beneficial trigger global positive changes.The information how to maximize the effect of training, shapes the exercise behavior and performance benefits related to both altered training routine (action) and the placebo effect stemming from thought-shaping information (expectancy). The placebo effect is a mind-set based on classical conditioning and trusted information from social resources. The invigorating feeling after exercise and the abundant media information about the benefits of exercise shape the individual’s expectancy, which mediates the psychological effect of exercise. The placebo effects are psychobiological events attributable to over all therapeutic context. These psychosocially induced biochemical changes in a patient’s brain and body affect the course of a disease and the response to the therapy .

At the beginning of the 1990s , it was recognized that entanglement can be quantified in degrees ranging from "maximally entangled" to not entangled at all. A large number of electrons that are partly entangled with each other, can bev concentrated into a smaller number of maximally entangled electrons, leaving the other electrons unentangled (a process known as entanglement distillation). A pair of maximally entangled electronscan spread the entanglement out over a larger number of electrons (so that they are now only partly entangled) in such a way that the total entanglement is conserved (a process known as entanglement dilution). The notion of a "degree of entanglement" has been the first measure of entanglement in the case of pure states: the greater the degree of violation of the inequalities, the greater the amount of entanglement. From an information theoretic point of view, the most remarkable feature of entanglement is the fact that in a maximally entangled state, all information is encoded in joint properties of the individual systems while the individuals themselves carry no information whatsoever. From a phenomenological point of view, when two physical systems come to an interaction, some correlation of a quantum nature is generated between the two of them, which persists even when the interaction is switched off and the two systems are spatially separated. Entanglement can be also created without direct interaction between the subsystems, via the so-called entanglement swapping Quantum entanglement describes a non-separable state of two or more quantum objects. Especially entanglement between objects of different nature like atoms and photons was achieved only very recently. The entanglement cannot be increased by local operations and classical communications, but can be realized by having two entangled particles emerging from a common source, or by allowing two particles to interact with each other.

Another possibility to obtain entanglement is to make use of a projection of the state of two particles onto an entangled state. This projection measurement does not necessarily require a direct interaction between the two particles. When each of the two particles is entangled with another particle, an appropriate measurement of the partner particles will automatically collapse the state of the remaining two particles into an entangled state. This striking application of the projection postulate is referred to as entanglement swapping or teleportation of entanglement. When a single atom is prepared in an excited state, it can spontaneously decay to the ground level and emit a single photon. Due to conservation of angular momentum in spontaneous emission the polarization of the emitted photon is correlated with the final quantum state of the atom. For a simple two-level atom, after spontaneous emission, the system is in a tensor product state of the atom and the photon. But for multiple decay channels to different ground states the resulting state of atom and photon is entangled. The physical process of spontaneous emission can not be explained by a semiclassical treatment of the light field but only by a quantum field approach.

Physical reality must be linked to:

* 1. The foundation of implicate order has a "structure" without any spatial and temporal connotation.
  2. The physical brain is responsible of disentanglment.
  3. The phenomenon of decoherence as a means to produce classicity: the explicate order .
  4. The "real" path of quantum entanglement is from implicate order towards explicate order. This is the "opposite" or "reverse" direction with respect to the classical quantum concept of entanglement. In other words, the classical-quantum entanglement is from explicate order towards implicate order and takes place before subject's visualization or subjective experience in the implicate order. The visualization (the explicate order) has to do with disentanglement and the brain is responsible for that.

The phenomenon of quantum entanglement is considered to be central to the field of quantum computation and information.Subtime1 (ts) is introduced as a reversible information interchange within an entangled system. Time is a change that can not be counted. Two atoms exchanging a photon with each other in perpetuity comprise a bipartite entangled pair. Each arrival of the photon (in ts) at the atoms represents a gain in information and departure represents a loss, i.e., entropy. Information and subtime are incremented along the photon’s path from the receiver’s point of view and decremented from the point of view of the transmitter. Each entangled system may evolve through its configuration space an arbitrary (and uncountable) number of times, but is inevitably constrained to a recurrence which is temporally indiscernible from any previous or successive recurrence.

Going from one to two atoms mediated by a photon, subtime becomes an isolated temporal experience of that two party system. Adding more atoms to the system, the number of discernible configurations increases non-linearly. The recurrence of the system becomes richer and more diverse, but the configuration space is still limited by the number of retroactively discernible configurations. Every entangled system evolves independently or expands as it receives new energy and decays as it decoheres. The simplest two atom entangled system would be almost 100 % reversible in its state of perpetuity between recurrences. Progressively larger systems of atoms have both a larger space of recurrences as well as a smaller probability of reversing (de-evolving) to a previously visited state, simply. Entanglement of quantum states is traditionally assumed to be a consequence of the principle of superposition.

Time is a change. When nothing changes, time stands still. When something changes, and then changes back, it is indistinguishable from time standing still. Entanglement represents a state of reversible change; it is impossible to “count” in an individual measurement, the number of recurrences within this state. This is one example of apparent randomness in quantum theory. It is not truly random in the sense of being unpredictable. But it is uncountable because a single one directional exchange between two entities from any arbitrary odd number of exchanges can not be distinguished in the Tc measurement events. Although motion may be continuous, it is the arrival of new information that presents a change of state in the receiver.

An indefinite number of subtime units can be added and subtracted between the nodes in a quantum network, but only the net will be experienced by an observer. Different observers will also experience different measurements, because early observers will extract energy/information which will then be no longer available to other observers. Only a hypothetical witness with perfect single traversal properties could, in principle, detect the vector sum of subtime units in the system being measured. In practice, the observer is fooled by the same stroboscopic, uncountable but indiscernible phenomena experienced by the system being measured. Subtime intervals are “elements of simultaneous reality”, terminated by the atoms on either end of the photon path. Subtime intervals are thus finite. The edges of the subtime graph are summed together to form the emergence of Tc. . The only objective reality that can be measured is through interactions—the ultimate locality. Entities must interact (touch, collide, bounce off, be absorbed, emitted etc.) in order to transfer information. However, the internal interactions of an entangled system are, by definition, unobservable. In bipartite entanglements, a photon (and its associated information) is trapped. It is perpetually bouncing between the atoms, just as virtual photons perpetually bounce between the orbiting electrons and protons in the nucleus of an atom. Subtime is the perpetual alternating direction of information flow through the bipartite interactions of atoms and photons. Subtime is continuous, and inseparable from the motion of photons or other Boson. Subtime is reversible: everything that happens in subtime can unhappen.

A photon that travels from A to B is usually followed by a traversal of that same photon from B to A. The state of the system is indiscernible from what existed before the first traversal, or indeed any prior or later traversal of the photon between them. An entangled system explores indefinitely within the irrecurrences, where the system neither gains nor loses energy/information. These are the maximally entangled states. Their existence will be outside of time and unobservable in Tc, either as emitters or absorbers. In ts photons may take any and all paths that exist in the apparatus as an uncountable number of times between each detection event. Between detection events photons are trapped/hidden, thus perpetuating the state of darkness. This provides a potentially straightforward classical explanation for the interference in the two-slit experiment, Feynman’s glass reflector system, quantum erasure, quantum teleportation, the quantum zeno effect and entanglement swapping.

Separate (non-interacting) entangled systems develop (evolve their state within the constraints of recurrence) entirely independently. Independent atomic clocks will exhibit random perturbations relative to each other. These jumps are affected by an increase in electromagnetic coupling to other systems (onset of decoherence) The quantum physics of light is a most fascinating field. The idea of hyper-dense coding is based on an interesting feature of entanglement. Many quantum communication protocols, like the entanglement-based version of quantum cryptography, quantum teleportation, and entanglement swapping, are based on the quantum correlations between distant entangled states.

Elementary particles such as electrons and photons can be entangled in pairs, meaning that while they appear to have separate lives they share a quantum-level interaction that defies a straightforward physical interpretation. In the case of electrons, this entanglement can manifest itself in spin states describing two particles that may be separated by enormous distances, yet somehow remain together in the same state. Consequently, a measurement performed on one electron’s spin appears to instantaneously determine the spin of its partner, even if it’s on the other side of the universe. Two unentangled electrons can exhibit any spin, up or down, completely independently of one another. The spins of electrons, however, are like colors that can vary according to the directions their spins are measured in. (352-358)

**Phase Locking/Coupling** : Phase locking establishes coherent oscillation among atoms and molecules in order to facilitate long-range interactions and energy storage as a key principle of energy resonance and information transfer in humans. In quantum field theory, phase locking facilitates order, coherence and collective modes of communication as an internal antenna that enables a person to exhibit self-awareness and coordination. The electrical activity of neurons oscillating simultaneously at the same frequency in separate parts of the brain is an example of the principle phase locking that has been applied to examine the role of neural synchronicities as a mechanism of neural integration of cognitive tasks. Coupled states refer to the condition wherein “two uniquely different kinds of physical substances begin to significantly interact with each other.” Purposeful coupling of matter and waves occurs in sub-cellular fields, resulting in structure and self-organization. Coupling is recognized as a key mechanism in information transfer between the energetic mind and the particulate brain. Electromagnetic coupling is a mechanism of information transfer between individuals. This energetic information exchange comprises a form of cardioelectromagnetic communication. The frequency architecture is not only defined by conditions enabling optimal phase coupling, but also by conditions enabling optimal phase decoupling to reduce interference between frequencies

### Phase plays a crucial role for coupling and establishes its impact physiologically as well as mathematically only, if a single oscillation is the dominant frequency in the analyzed band. The dominant oscillation may exhibit a large jitter in a broad band, as the case for hippocampal theta. In a broad band with different oscillations, the phases of different frequencies tend to cancel each other. Thus, the critical role of phase for cross-frequency coupling can be taken as strong evidence for the existence of distinct center frequencies. For longer time periods, phase coupling is optimal and stable only for harmonic frequency ratios. The observation that neighboring center frequencies of traditional EEG bands exhibit a 1 : 2 ratio suggests a binary hierarchy of frequency domains. The term frequency domain is used to emphasize that (i) frequencies of traditional frequency bands are 1 : 2 related and (ii) reflect cognitive processing domains. Frequency domains establish a binary hierarchy relative to each other but are harmonically related to other frequencies at ratios that do not belong to the subset of binary multiples. The requirement for a harmonic frequency relationship does not apply to phase coupling in very short-time windows.

### A transient and brief phase coupling between many frequencies can occur during a short-time window. In humans, hippocampal broadband frequency phase clustering has been demonstrated during successful word recognition and increased frontal theta phase modulation of posterior gamma amplitude coupling during visual encoding.The left medial temporal lobe (Hipp, AMG and PHG), the ventromedial prefrontal cortex (vmPFC), and parietal regions (PCC and SPG) work in tandem during recall of self-relevant episodic memories. This synergy occurs through the complex coordination via frequency-specifc and cross-frequency coupling. The medial temporal lobe orchestrates the gamma activity in the ventromedial prefrontal cortex and parietal regions with its high theta phase. These two areas synchronize in phase their gamma activity with neighboring regions to valuate and construct the memory. A high theta synchronization occurs between the posterior cingulate cortex and medial prefrontal regions, which could show the transfer of sub-episodes of memory from posterior to frontal regions. (359-385)

### Hyperscanning is a form of neuroimaging experiment where the brains of two or more participants are imaged simultaneously whilst they interact. Within the domain of social neuroscience, hyperscanning is increasingly used to measure inter-brain coupling (IBC) and explore how brain responses change in tandem during social interaction. In addition to cognitive research, some have suggested that quantification of the interplay between interacting participants can be used as a biomarker for a variety of cognitive mechanisms as well as to investigate mental health and developmental conditions including schizophrenia, social anxiety and autism. Beyond simple ‘neural alignment’ (inter-brain similarity to a given experience) available from sequential neuroimaging, hyperscanning paradigms measure complex dynamics between interactive brains, as they continuously and mutually adapt over their interaction. Measuring the brain activity of interacting subjects allows for real time Access to the reciprocal coupling of neural processes that enable interpersonal movement synchronization within a millisecond time scale. In minimalisitc tasks, different parameters, such as visual contact, feedback and mode of synchronization (in phase vs antiphase) can be manipulated easily. Coordinated actions between the subjects involved oscillatory couplings between the two brains, primarily over frontal-central connections. The synchronization is exceptionally robust in low frequency ranges, between 0.5 and 7.5 Hz with a maximum in the theta frequency at 3.3 Hz. Musical performances combine intrapersonal action coordination and interpersonal action synchronization as well as continous interaction.

### Developments in cognitive neuroscience have led to the emergence of hyperscanning, the simultaneous measurement of brain activity from multiple people. Hyperscanning is useful for investigating social cognition, including joint action, because of its ability to capture neural processes that occur within and between people as they coordinate actions toward a shared goal. Correlation between signal amplitude or power in various frequency bands has been used to characterize synchrony. When individuals interact with others, perceived information is transmitted among their brains. The EEG based hyperscanning technique provides an approach to explore dynamic brain activities between two or more interactive individuals and their undrelying neural mechanisms.Social interaction is at the core of human behaviors, involving different kinds of interpersonal synchronies. Synchronous behaviors play a central role in establishing and promoting social ties. Through social interactions with others, human beings know each other and form a family or state.

### A technique called hyperscanning or pseudo-hyperscanning is used to assess the level of between –brain coupling, which requires the measurement of brain activities of two or more partcipants involved in social interactions. While hyperscanning is a measurement of brain activities of two participants at the same time, pseudo-hyperscanning is a similar measrement but measures each participant at a time. Mutual gaze and shared attention play an essential role in our abilities to detect others’focuses of interest, as well as to infer their intentions, desires and thoughts. The deciison making process requires higher degree of cognıtıve involvement of goal directed behaviors, social cognition and theory of mind abilities between interactive individuals in real life. Affective communication is a complex process during which interactive individuals express and perceive emotional signals and exchange information about internal affective states. Emotions play an important role in regulating and motivating a person’s thoughts, feelings and behavior in every aspect of people’s life. Brain to brain coupling is a neural marker for interpersonal communication of affection. By means of the EEG based hyperscanning technique showed that theta –alpha hyper-brain networks bound the two brains of kissing partners together with a method of network construction based on the cross frequency coupling, since the brain to brain coupling is a neural marker for interpersonal communication of affection. A relatively weaker inter brain coupling between the right parietal regions of the female partner and the right parieto-occipito-temporal areas of the male partner in the control condition.

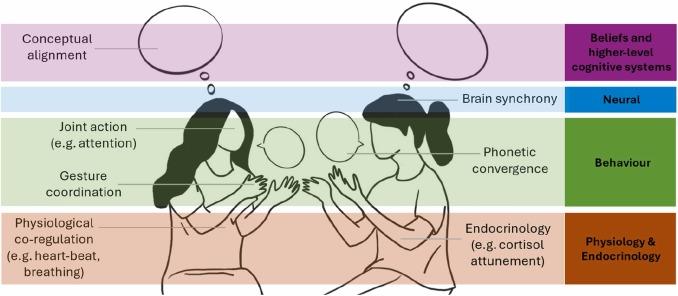
### Co-presence of two speakers can result in their autonomic physiologic coupling. Based on quantifying functional similarities or temporal synchronization between brains during social interactions, inter-brain synchrony or phase coherence is an important index of interpersonal interaction and attributed inter-brain synchrony or phase coherence. The term “hyperscanning” refers to simultaneous recording of [brain activation](https://www.sciencedirect.com/topics/neuroscience/brain-activation) from multiple subjects. Social communication emerges as two individuals act upon each other, and this communication constitutes a two-in-one nonlinear complex via inter-subject correlation of behavior and [neural activation](https://www.sciencedirect.com/topics/psychology/neural-activation). For the purpose of exploring the properties of social interactions, the most efficient way to use hyperscanning neuroimaging data is to calculate inter-brain effects such as correlative (functional connectivity) or causal (effective connectivity) relationships across regions within the two brains. Functional magnetic resonance imaging (fMRI) is capable of precisely defining the epicenter of brain activity. The spatial resolution of fMRI (2–3 mm) is significantly greater than that of electroencephalogram (EEG; 1–2 cm), or functional near-infrared spectroscopy (fNIRS; 2–3 cm).

### Only fMRI can record activation of deep brain structures. The regions associated with our social skills are located in deep brain structures such as the [medial prefrontal cortex](https://www.sciencedirect.com/topics/psychology/medial-prefrontal-cortex), [orbitofrontal cortex](https://www.sciencedirect.com/topics/psychology/orbitofrontal-cortex), [striatum](https://www.sciencedirect.com/topics/psychology/striatum), and [amygdala](https://www.sciencedirect.com/topics/neuroscience/amygdala). Scalp EEG and fNIRS cannot record such deep structures. Although the epicenter can be estimated mathematically using EEG, precise definition is difficult when there are multiple epicenters, or the epicenters are distant from the electrodes. The same is true in hyperscanning neuroimaging. fMRI is regarded as the first-line technique for determining which brain regions constitute the inter-brain [neural network](https://www.sciencedirect.com/topics/psychology/neural-network) during [social interactions](https://www.sciencedirect.com/topics/neuroscience/social-interaction). Using hyperscanning fNIRS, it has reported that the inter-brain coherence represents the effort to imitate partner's movement. For example conversation can cause inter-brain coherence. Inter-brain effects exhibit different patterns when verbal information is absent in vocal communication. Inter-brain effects are tightly associated with properties of interaction such as task structure, interaction structure, and goal structure. Hyperscanning EEG study has revealed that goal structure (i.e., competitive vs. cooperative task) has an effect on inter-brain network patterns. The social interactions that occur in real life exhibit more complex patterns than those that arise in experiments.

In the social interactions, such as learning processes, the relationship between two individuals is asymmetric, and each individual plays different role (e.g., speaker and listener). When there is asymmetry of roles in communication, causality between two brains might be a better neuromarker of interaction quality than coherence or synchronization. For example, during verbal communication, causality of EEG between team members in a cooperative relationship is more significant than causality between individuals on different teams, who are in a competitive relationship. Causality can be a better neuromarker of the quality of asymmetric social interaction. For example, causality from teacher's brain to student's brain can be used as a neuromarker of how effectively the teacher can make the student understand. Hyperscanning EEG–fMRI is valuable in precisely defining brain regions associated with EEG causality in asymmetrical social interactions. Not only the quality of social interaction, but also our behavior and psychological perspectives on social interactions, can be quantified using inter-brain effects. Individual behavior and psychological perspectives can be understood in the individual brain. Our behavior and psychological perspectives during social interactions are clearly influenced by those of our partners. Inter-brain effects could provide better markers of behavior and psychological perspective than activations within a single brain. A subject's intention to defect on their partner can be predicted with high accuracy before the decision by evaluating changes in the inter-brain network pattern

Multiple organisms can constitute a single dynamic complex system through their interactions, such as the synchronized flickering of certain types of fireflies and the synchronized cries of Japanese tree frogs. For these phenomena, mathematical modeling has played an important role in revealing the mechanism underlying the emergence of synchronization, as well as its function. Two individuals who are coupled through social interaction constitute a dynamic complex system that cannot be reduced to the individual level. Hyperscanning EEG–fMRI allows us to look at the two-in-one system from a different perspective.Decoupling also plays an important role as the prediction of the bandwidth of traditional frequency bands shows. Like hyperscanning, pseudo-hyperscanning also demands synchronization between recordings. The principal difference between the methodologies is that pseudo-hyperscanning requires the alignment of signals recorded from different brains obtained at different times. Both techniques are commonly used inside the ‘two-person neuroscience’ (2PN) framework  to investigate the specific neural mechanisms underpinning social interaction. Results revealed that effective communication is associated with a pattern of inter-personal neural covariation. When individuals interact with others , perceived information is transmitted among their brains.

Although the interpersonal closeness and interactivity dimensions can be considered as two separate, non-mutually exclusive dimensions, they can interact. For example, engaging in a conversation may be related to different neural patterns compared to sharing an experience with little interaction, which in turn may differ from solo-experience, and these patterns may additionally differ depending on whether either of these situations occurs between strangers, acquaintances or long-term friends or lovers. A similar account of three interactive experimental dimensions comprising the factors “experience” (i.e., differentiating between detachment versus engagement), “participation” (i.e., differentiating between the observation of inert stimuli versus structured or dynamic interaction) and “data collection & analysis” (i.e., differentiating between the measurement of data from single versus multiple individuals) has emphasized that high interactivity often correlates with unstructured environments, whereas low interactivity often aligns with more structured settings.



**Fig.57.Interpersonal dynamics across different modalities during naturalistic interaction** Relational Neuroscience is interested in modelling the interpersonal dynamics between at least two individuals during the free exchange of signals. Such signals come from different modalities, giving rise to convergence across physiological/endocrinological, behavioural, neural signals, and high-level cognitive systems, such as beliefs.

### Hyperscanning approaches represent an important paradigm shift from single/first-person neuroscience to two/second-person neuroscience . The applied technique simultaneously records neural activity from two or more brains and thereby enables a major step forward in understanding the mechanisms of inter-brain dynamics during socially shared experiences. In contrast to sequential scanning assessing one single participant at a time, hyperscanning studies can grasp the unique effect of real-time interactive minds. This particularly holds true when hyperscanning is used in relatively unconstrained and naturalistic settings with mobile measures of brain activity.

Social interactions involve a series of mutual and joint decisions by two or more individuals to complete a task, solve a problem, move in synchrony whilst playing music and dancing, and engaging in conversations while exchanging communicative signals. All these decisions can be summarised under the umbrella term of cooperation. Dyadic cooperation necessitates successful transfer of verbal and nonverbal information as part of interpersonal communication. People engaging in interaction need to coordinate their behaviours in order to facilitate such exchanges (e.g., turn-taking within conversations).Communication is characterised by the inherently rhythmic or quasi-rhythmic exchange of many verbal and nonverbal signals, that leads to the emergence of mutual entrainment of brain rhythms of each person to the communicative rhythms of their interaction partner. Neural entrainment between interacting partners emerges similarly to a radio being tuned to the correct input frequency. This bi-directional process is enhanced when interaction partners pay attention and adapt to each other, and has been associated with better mutual processing of communicative signals.

### Combining hyperscanning with detailed behavioural coding reveal that high levels of behavioural reciprocity and vocal turn-taking – that are indicative of mutual engagement and connection in a social exchange. IBS is a neural correlate of successful communication and cooperation indicative of high levels of mutual attention, efficient information transfer, and mutual predictability, which support dyadic social coordination. Interactivity seems to be a driving factor, above and beyond shared sensory input, as IBS ,rises with increasing levels of mutual engagement (e.g., compared to rest and individual engagement) and significantly correlates with behaviours and interaction outcomes and reflects mechanisms of mutual attention and prediction . *As part of interpersonal exchanges, individuals engage in the mutual sharing of affective and emotional states. With regards to the Relational Neuroscience dimensions, particular interest for research on empathy is the interpersonal closeness dimension.* Empathy, that is the capacity to emotionally immerse oneself in someone else's affective and emotional experience, plays a pivotal role in nurturing interpersonal connections and societal harmony by facilitating the exchange of experiences, needs, and desires among individuals.

Attachment and bonding constitute vital functions for human survival, development, and mental and physical health across the lifespan. Regarding child-parent attachment and parent-child bonding, investigations reported increased IBS during different interactive tasks in dyads of biologically related children and their mothers as opposed to pairings of children with stranger females. Data showed that IBS during cooperation correlates with dyadic interaction quality in mother-child dyads, caregiving beliefs in father-child dyads and self-reported child-mother attachment. BBS may be involved in attachment and bonding within romantic relationships For instance, naturally occurring patterns of electrodermal activity and behavioural motion in men and women are associated with the outcome of a first date. Participants who showed a high consensus with their romantic partner in the evaluation of relationship quality exhibited increased responses to affective touch of the romantic partner in reward-associated brain areas. More specifically pertaining to co-regulation and social allostasis under distress, hand holding in romantic partners during pain administration correlated with increased IBS in a network that mainly involved the central regions of the pain target and the right hemisphere of the pain observer, and further correlated with analgesia magnitude and observer’s empathic accuracy.

Further supporting evidence has come from a study combining synchrony in skin conductance responses (SCR), subjective pain ratings and brain activity obtained through fMRI, probing the effects of social support on pain processing. The study found that synchrony in couples’ SCR was correlated with reductions in self-reported pain, and individual differences in synchrony were correlated with the partners’ trait empathy. Increased IBS when one interaction partner is in distress and the other partner offers co-regulation reflecting the efficiency of social allostasis. IBS emerges early in human development and can already be observed in the early interactions between infants and their caregivers. The coordination of behavioural and biological (including IBS) dynamics during social contact is a fundamental characteristic of human attachment relationships with deep ontogenetic roots in the infant-caregiver bond. The youngest age at which IBS has been documented in infant-caregiver dyads to date is at 4–6 months. Using fNIRS hyperscanning [https://www.sciencedirect.com/science/article/pii/S0149763424004482](https://www.sciencedirect.com/science/article/pii/S0149763424004482#bib176), it has been  found that caregivers and infants showed more synchronised brain activities when the caregiver held the baby compared to when both were seated apart . During a face-to-face free play interaction, longer durations of affectionate touch (e.g., soft stroking) are positively associated with IBS. These findings underline the crucial role of social touch as a communication channel at this young age. Infants and caregivers already exchange vocalisations in so-called proto-conversations at this age. An in-depth analysis of the vocal turn-taking patterns in the same dyads during free play revealed that higher turn-taking frequency was associated with enhanced IBS. In older infants, at 9–15 months, fNIRS hyperscanning showed that caregiver-infant IBS was higher when infants and caregivers were engaged in a face-to-face interaction with each other, compared to when each was interacting with another person in the same room. Higher levels of IBS were observed around moments of mutual gaze and infant smiling, confirming the role of gaze and emotional expressions as further early emerging modes of communication. IBS between infants and caregivers seems to be linked to mutual engagement and the exchange of communicative signals in face-to-face interactions. Higher levels of mutual influence between 8-month-old infant and adult EEG time series during eye contact compared to averted gaze have been reported.

In the *physiology* domain, synchronisation has been observed, at the level of the autonomic nervous system by means of heart rate variability and respiration,  and mother-infant brain activities (fNIRS), physiological arousal (respiratory sinus arrhythmia) and behaviour (social touch and affect) have been measured in different conditions. Findings revealed that both neural and physiological synchrony between caregiver and infant were elevated during a face-to-face free play interaction compared to a condition with no direct contact. During the free play interaction, divergent behavioural correlates were observed. While neural synchrony is related to duration of affectionate touch, physiological synchrony is related to infant negative affect. These results hint at different mechanisms and potential functions of neural versus physiological synchrony. Whereas neural synchrony seems to be related to communication across different signal modalities, physiological synchrony may allow for early co-regulation in caregiver-infant dyads.Infant expressions of negative affect induce arousal in the caregiver and elicit comforting behaviours to calm the dyad down again. Using whole-day electrocardiographic recordings,  showed that caregivers tend to mimic their babies’ autonomic state preferentially when babies’ arousal is high and requires the caregivers’ co-regulation. This converging evidence is another important reminder that “more synchrony” is not always better for the interaction or the participating individuals. Instead, flexibly switching between more and less synchronised states may be optimal. These findings help to illustrate that synchrony on different levels of observation (e.g., neural, physiological) can have very different mechanisms of emergence and functions.

The primary focus in empathic stress studies is usually directed towards synchronisation in physiological variables such as measures of autonomic and particularly sympathetic activity (i.e., facial thermal imprints, heart rate, inter-beat interval, pre-ejection period, respiratory sinus arrhythmia) as well as salivary cortisol. , synchronisation has been reported in stress hormones (e.g., salivary cortisol) over durations of one to five days. Findings show that stress resonance as indexed by physiological synchronisation has a higher likelihood to arise in emotionally close relationships (e.g., romantic partners, mother-child pairs) and with spatial proximity (i.e., in real-presence), but can also occur in strangers from simple exposure to videos . Correlations between parental and child salivary oxytocin have been observed and linked to parental caregiving behaviours and child social reciprocity. Intranasal application of oxytocin was shown to increase behavioural coordination and neural synchrony between interacting men.

Neuropharmacological work can thus reveal processes of physiological synchronisation as well as its links to IBS. Based on early experiences of sensitive caregivers responding to the child’s signals and physiological and emotional needs, children learn how to co-regulate and ‘tune-in’ their internal bodily processes to those of the people interacting with them. Long-term, this co-regulation process supports the development of adequate representations and predictions about positive social interactions and relationships. This enables one to competently engage in social exchanges and learn how to form and maintain social bonds with others throughout the lifespan, including with peers and later with romantic partners (interpersonal closeness dimension).

The focus is on the function of IBS in promoting long-term attachment and bonding looking at child-caregiver interaction and how this shapes future adult interactions, across physiological, endocrinological and neural levels and considering behavioural synchrony as biomarker for patient-therapist relationships as well as for some patients’ pathological traits. Cardiac physiological synchrony between two persons is considered to be an important component of social interaction. The heart is more than just the organ that maintains and adjusts blood flow to organs. The way we experience life and feel about it constantly influences our hearts and vice versa.The ability to perceive periodicity and movement in time is elemental for human interactions. Both music and dance have been understood as fundamental parts of society and culture, bringing people together and strengthening social bonds. The key to movement synchronization is termed motor entrainment, also referred to as sensorimotor synchronization (SMS). Motor entrainment represents the process by which motor control can be precisely adapted to the onset of external rhythmical stimuli, thus timing movement accurately and even allowing for synchronization. The pacing rhythm perceived by selectively blocking sensory modalities can provoke different degrees of tapping synchrony influencing cardiac PS. Contrary to external pacing, where individuals can only follow the rhythm, in self-paced movement synchronization, there are always two roles: the sender, who is producing the rhythm, and the receiver, who follows it. This distinction is especially important since depending on the role, movement synchronization is processed differently by the corresponding brain areas, namely the basal ganglia and the cerebellum.

Cooperation is a complex feature of all social species, including human and non-human animals which usually points at interaction between actors to reach a common goal. This definition partially overlaps with the concept of joint actions which is any kind of social interaction in which subjects share intentions. This leverages not only on social cognition processes, in particular on social interaction, but also on cognitive and affective mechanisms of a single subject.  Emotions affect decision-making process, and human choices, including cooperation with others. From a neurophysiological point of view, the effects of emotions can be easily measured because most body parameters such as temperature, heart rate (HR), breathing and sweating are unconsciously controlled by the autonomic nervous system. Cardiovascular, electrodermal activity (EDA) and respiratory measurement have been considered as fundamental biomarkers of emotions. In particular, HR and skin conductance level (SCL) are two autonomic variables employed more often than all of the other autonomic variables in literature for the analysis of emotions. The joint analysis of EDA and HR was born in the framework of social physiological compliance (SPC) .

The physiological compliance defined as the psychophysiological change of a joint nature, has been a used concept to analyse social dynamics. High physiological compliance is associated with high social interaction with different shared feelings. Higher synchronization in HR has been correlated with growing trustfulness in dyads. Higher synchronization in EDA has been found in dyads after receiving positive/negative feedback of their performance as a team during an attention task as well as in negative interaction compared to positive interaction in romantic couples. Cooperation has different effects on autonomic measures compared to competition. Whereas SPC deals with autonomic signals, hyperscanning handles the synchronized acquisition of brain signals of two different subjects. While high spatial resolution of fMRI provides detailed information on deep cerebral areas involved in social interaction, low ecological level and low temporal resolution of this scanning method prevents the acquisition during real interactive tasks. For this reason, EEG technique has been used to analyse two or more people really interacting during ecologic tasks, for example, during group interactions in class.

EEG-hyperscanning applications have shown, through paradigms based on joint actions that while two subjects interact, their brain activities are subjected to synchronization. High inter-brain synchrony has been observed between the right temporoparietal (RTP) and frontal areas during cooperation and in the posterior region of the right middle and superior frontal gyrus during cooperative and obstructive interaction during a Jenga game. Higher frontal inter-brain synchrony in the theta band has been associated with a mentalizing process in the case of cooperation when members of a couple thought more about their partner’s conduct, while lower inter-brain synchrony in the beta band has been associated with competitive behaviour during a computerized pong-game. The neural coupling in EEG hyperscanning has been analysed with different methods that could be summarized in three domains: amplitude covariance, phase synchrony and analysis of causality between time series.(386-397)

The lung and heart are ‘mechanically’ closely coupled organs. The heart, as a ‘double’ organ, consists of a pair of chambers, the left and right atrium, and ventricle. It pumps blood synchronously into two different circuits, the lung and the body circuit. The close relationship between the lung and the heart is functionally reflected by m : n amplitude envelope coupling in a way that the phase of the slower rhythm (breathing) modulates the ‘amplitude’ (cycle length) of the faster rhythm (heart beat).Envelope coupling between BP and HR is due to the baroreflex loop. When BP increases, HR decreases and conversely, when BP decreases, HR increases. Changes in HR and BP do not occur simultaneously because of inertia in blood flow. The delay lies in a range of roughly 5 seconds and determines the resonance frequency of the hydrodynamics of the vascular system. Because the delay operates for up- as well as down regulations, resonance frequency has a period of about 10 seconds (i.e., a frequency of about 0.1 Hz). The baroreflex-induced change in HR is almost instantaneous, but the subsequent hydrodynamic (‘mechanic’) change is delayed by about 5 seconds.

### Resonance breathing can be observed, when subjects breath at the same frequency (at around 6 bpm; i.e., every 10 seconds or 0.1 Hz) as the BP wave and is characterized by six facts:

### 1. Phase synchrony : In adults, when respiration and heart rate signals rise and fall at the same time (0°), this maximally stimulates the baroreflex and increases RSA. Strong resonance effects, increase RSA and allow HRV biofeedback training to more effectively stimulate and strengthen the baroreflex

### 2. Peak-trough amplitude: larger peak-trough differences signal greater resonance effects and contribute to more effective baroreflex activation

### 3. LF power. The baroreflex system exhibits resonance because it is a feedback system. With a constant delay, cardiac vagal activity increases when individuals engage in slow paced breathing within the LF range

### 4. Maximum LF amplitude peak : Larger LF peaks reflect stronger resonance effects due to greater synchrony between breathing and heart rate.

### 5. Smoothness of the heart rate curve envelope: Smooth heart rate waveforms permit closer phase synchrony with respiration waveforms

### 6. Fewest LF peaks: Breathing within a narrow band within the LF range, increases resonance effects and RSA.

### One central aspect of this phenomenon is that three body oscillations, BF, HRV (i.e., the RSA peak in HRV) and BP become phase locked (although with different delays) with the same frequency at around 0.1 Hz. HR (at around 1 Hz) exhibits a clear 10 : 1 frequency ratio relative to the frequency of BF, BP, and HRV which are phase locked to each other. This harmonic relationship also invites a phase coupling with HR. At least three different aspects can be distinguished, one referring to energy demands, another to resonance properties, and another to emotional changes. Heart rate and breathing vary in phase with each other when people do resonance frequency breathing. When people breathe at the frequency of the baroreflex system, about 0.1 Hz, heart rate and blood pressure have been found to oscillate 180° out of phase, while heart rate and breathing are in phase (zero-degree phase). Thus breathing stimulates the baroreflex by augmenting the baroreflex response with each breath, an effect that is magnified by resonance properties in the baroreflex system.

### Heart rate variability (HRV), that represents fluctuations in the time intervals between successive heart beats, which are termed interbeat intervals, is an emergent property of complex cardiac-brain interactions and non-linear autonomic nervous system (ANS) processes. A healthy heart is not a metronome because it exhibits complex non-linear oscilaltions characterized by mathematical chaos. Heart rate variability (HRV) biofeedback, displays both heart rate and respiration, so that individuals can then adjust their physiology to improve affective, cognitive and cardiovascular functionning. It is a simple and noninvasive method for brain stimulation including paced breathing at a rate of about 6 breaths per minute (0.1Hz), which is slower and more rhythmical than natural breathing. HRV biofeedback has been used to successfully treat a wide spectrum of diseases, such as asthma, COPD, IBS, fibromyalgia, hypertension, depression, anxiety, PTSD, and insomnia. Such diverse clinical applications for HRV biofeedback suggest a centrally-mediated mechanism of action. The central premise of the HRV biofeedback resonance frequency model is that the adult cardiorespiratory system has a fixed resonance frequency. Stimulation at rates near the resonance frequency produces large amplitude blood pressure oscilaltions that can increase baroreflex sensitivity over time. Slow paced breathing is a central component of HRV biofeedback because respiratory sinüs arrythmia (RSA) amplitude (peak –to-through ) herat rate difference across the breathing cycle ) increases with slow breathing. The resonance frequency training model identifies the respiration rate that produces the greatest heart rate oscillations by stimulating teh baroreflex, which is the homeostatic system that regulates blood pressure using blood pressure baroreceptors.Paced 0.1Hz breathing triggers resonance in the cardiovascular system, eliciting high amplitude oscillations in physiological processes, such as heart rate, blood pressure, stroke volume, and vascular tone. For example, breathing at this frequency maximizes the amplitude of the 0.1Hz oscillation in HR i.e., HR can change from ∼45 to ∼105 bpm during the oscillation period. These resonant oscillations robustly modulate blood flow in the aorta and carotid arteries.

### The goal of HRV biofeedback is to increase RSA, which is heart rate acceleration and deceleration across the breathing cycle in order to enhance autonomic homeostatic capacity. RSA involves respiration-driven changes in heart rate that are mediated by the *vagus nerve*, which conveys baroreceptor inputs to the brain and then returns them to the heart after integration in the brain. The cardiovascular center inhibits vagal firing and heart rate speeds at inhalation and restores vagal inhibition and heart rate slows at exhalation. HRV biofeedback increases cardiac vagal activity and stimulates the negative feedback loops that are responsible for homeostasis. HRV reflects medial prefrontal cortex (mPFC) integration with brainstem regulation of the heart by the nucleus tractus solitarius . The neurovisceral integration model that provides a window into neurocardiac function, describes the interrelationship between the prefrontal cortex, HRV, and executive function Increased HRV may enhance top-down mPFC control of emotional health. Heart rate variability is generated by interdependent regulatory systems with widely varying rhythms that enable us to adapt to physical and psychological challenges.

### Short-term (∼5 min) HRV measurements are produced by interactions among the autonomic, cardiovascular, central nervous, endocrine, and respiratory systems that utilize feedback from *baroreceptors* (receptors that detect blood pressure changes) and *chemoreceptors* (receptors that monitor chemicals like blood gases). Heart rate variability is a marker for the regulation of integrated functions and efficient allocation of limited self-regulatory resources, which are indicated by the vagal traffic to the heart. Both regulatory capacity and adaptability depend on healthy variability due to increased vagal traffic. Variability enables adaptability. HRV appears to index autonomic functioning, blood pressure, cardiac functioning, digestion, oxygen and carbon dioxide exchange, vascular tone (diameter of resistance vessels), and possibly facial muscle regulation. HRV reflects the vagal contribution to executive functions, affective control, and social self-regulation. Multiple overlapping system oscillations, characterized by mathematical chaos, produce the complex non-linear oscillations of a healthy heart. “Oscillatory patterns with greater complexity, that occur when a number of oscillatory patterns overlap, are described as ‘chaotic.’ Chaos reflects the simultaneous operation of numerous control processes”

### The integrated action of multiple control systems contributes stability in response to challenges like exercise and stressors. The interdependence of these control systems means that interventions like slow paced breathing can initiate system-wide changes to increase HRV. Slow paced breathing at the rate of 6 breaths per min produces large-scale increases in cardiorespiratory synchrony. Healthy variability allows rapid responses to changing workloads and unpredictable environmental challenges and contributes to regulatory capacity. Whereas healthy biological systems show spatial and temporal complexity, diseases like cardiac conduction disorders can decrease or increase complexity.

### *Resonance,* a property of the baroreflex system, is an amplification process in which stimulating a negative feedback, self-corrective system at its intrinsic frequency generates high-amplitude oscillations at that frequency. The mechanism for this effect lies in a confluence of processes:

### (1) phase relationships between heart rate oscillations and breathing at specific frequencies,

### (2) phase relationships between heart rate oscillations and breathing at specific frequencies,

### (3) activity of the baroreflex, and

### (4) resonance characteristics of the cardiovascular system

### In the cardiovascular system, the volume of blood in the vascular tree is responsible for the delay in the entire baroreflex loop across inhalation and exhalation. The *resonance frequency model* proposes that breathing, rhythmic skeletal muscle tension, and emotional stimulation at the resonance frequency (∼ 0.1 Hz) can increase RSA and HRV. At the resonance frequency in adults, when heart rate rises during inhalation blood pressure starts to fall ∼ 5 s later. The strength of heart rate oscillations increases 4–10 times from resting baselines (difference between minimum and maximum heart rate) External stimulation such as slow paced breathing or rhythmic skeletal muscle tension near an individual’s precise resonance frequency produces the greatest RSA and HRV and increases *baroreflex gain* (heart rate change per 1 mmHg change in blood pressure.The resonance frequency ranges from 4.5 to 6.5 bpm for adults and 6.5 to 9.5 bpm for children. The difference by age group arises because children are smaller tahn adults and have smalelr vascular trees and less inertia due to blood volume. Adult complaints like asthma, generalized anxiety disorder and low back pain as well as dysfunctional breathing behaviors like overbreathing is associated with rapid breathing. Resonance frequency assessment is contraindicated for those whose sinüs rhythm is driven by a pacemaker that regulates HRV externally and whose overbreathing compensates for increased acidity in the blood due to conditions like kidney disease. Slow paced breathing would increase CO2 levels in the blood causing acidosis.

### *HRV frequency-domain metrics* calculate the spectral distribution of signal energy. HRV biofeedback is concerned with the *very-low-frequency* (VLF; 0.0033–0.04 Hz), *low-frequency* (LF; 0.04–0.15 Hz), and *high-frequency* (HF; 0.15–0.40 Hz) bands. LF power is an important indicator of HRV biofeedback training success because the baroreceptor reflex’s resonance frequency resides within this range. Increased RSA and HRV occur in the LF range. HF power is due to parasympathetic activity, and the natural logarithm of HF power indexes cardiac vagal tone. Larger peaks indicate greater resonance effects due to increased breathing and heart rate synchrony. Breathing in a narrow frequency range around the resonance frequency better stimulates the baroreflex and increases RSA than breathing in a wider frequency range. *HRV time-domain indices* quantify the amount of variability in a series of interbeat intervals. HRV time domain and frequency domain norms are influenced by age, sex, and fitness During resonance frequency assessment, clinicians can measure respiration rate, heart rate, heart rate-respiration phase synchrony, heart rate peak-trough amplitude, mean LF power, the magnitude and number of peaks within the LF band, and the smoothness of the heart rate curve envelope during each breathing trial.

### Variability in the timing of interbeat intervals may promote adaptive capacity. Cardiovascular health and optimal affective, cognitive, and social functioning depend on complex non-linear oscillations produced by complex neurocardiac interactions and non-linear ANS processes. Stimulation of the baroreflex by breathing and rhythmic skeletal muscle tension near the resonance frequency can produce immediate large-scale increases in RSA compared with that at resting baselines. Physiologically, there are two well described coupling principles that govern brain and body oscillations. In a mathematical sense, amplitude (envelope) coupling works for any m : n frequency ratio, where the phase of the slower frequency m modulates the envelope of the faster frequency n, but phase coupling requires a harmonic (integer) relationship between m and n . (398-399)

Phase coupling operates at the temporal precision of the faster oscillation, but amplitude coupling operates at the temporal precision of the slower oscillation. For phase coupling, the temporal precision is higher. It is characterized by the excitatory time window (phase) of the higher frequency. The reason is that the excitatory time window of the faster oscillation – which can be driven by the phase of the slower oscillation - is smaller than that of the slower oscillation. Cross frequency phase coupling is closely associated with widespread and long range brain synchronization for cognitive top down control. While slow oscillations (in the delta, theta, alpha, and beta frequency range) play an important role in cognitive top–down control ,m : n phase coupling (for m ≤ beta) is an important mechanism for the downstream control of neuronal synchronization in anatomically distributed neural circuits.Based on the specific properties of cross frequency phase coupling, the center frequencies of traditional EEG frequency bands are harmonically related and form a binary hierarchy of frequencies (delta = 2.5 Hz, theta = 5 Hz, alpha = 10 Hz, beta = 20 Hz, gamma1 = 40 Hz), in which the neighboring higher frequency always is twice as fast than its slower neighbor. This harmonic frequency architecture allows optimal brain communication during [cognitive processing](https://www.sciencedirect.com/topics/neuroscience/cognitive-process) demands. This binary hierarchy extends ‘down’ to and allows to predict the frequencies of body oscillations. These frequencies can be associated with heart rate (1.25 Hz), the frequency of muscle contraction supporting inhaling and exhaling (0.625 Hz), and [breathing frequency](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/breathing-rate) (0.3125 Hz).

The binary hierarchy brain body oscillation theory refers to two groups of predictions.

### During alert wakefulness binary multiple frequency ratios are expected between brain and body oscillations (AF: HR, AF : BF) and body oscillations (HR : BF).

### During sleep, irrational ratios are expected between brain and body oscillations (SF: HR, SF : BF), but a binary multiple ratio for body oscillations (HR : BF).

### For wakefulness, a period preceding sleep onset, only one prediction (regarding the expected ratio of 1: 4 for HR : BF) is supported. While people were physiologically awake, there is no active [cognitive processing](https://www.sciencedirect.com/topics/neuroscience/cognitive-process) or movement during these periods, and HR. Sleep spindle frequency is irrationally related to body oscillations (HR and BF), whereas the harmonic ratio between the two body oscillations remained constant throughout wakefulness and sleep. possibly reflecting decreased body awareness. During rest, multiple breathing frequencies are present, from which one frequency exhibits the predicted ratio of 4. During sleep, however, all spectra exhibited one peak only. Coupling between HR and BF is stronger during sleep as compared to wakefulness. During task performance brain and body oscillations are frequency coupled, whereas during sleep they become decoupled, although body oscillations remain coupled at binary integer ratios. This finding is consistent with network physiological approaches, which show that in sleep the high correlation between brain and body activity (observed during wakefulness) disappears, although activities within the brain and the body remain highly correl highly correlated). The [neural network](https://www.sciencedirect.com/topics/neuroscience/neural-network) architecture of the brain consists of different clusters that operate dynamically with different frequencies and changes in the excitation/inhibition ratio lead to a shift in frequency .

### Breathing frequency is the only oscillation that can be controlled volitionally. Studies focusing on body-brain coupling show that breathing entrains a variety of cortical oscillations. Animal studies have shown that neurons in the [limbic system](https://www.sciencedirect.com/topics/neuroscience/limbic-system) oscillate in phase with breathing . The characteristic feature of this coupling is that breathing phase is coupled with the power envelope of delta, theta and gamma oscillations. When breathing is diverted away from the nose, this entrainment diminishes. Synchronization with the respiratory rhythm is an important factor for olfactory coding and memory in rodents and humans .Recent findings show that non-olfactory cognition also is phase locked with inhalation. As an example, using intracranial EEG recordings, fearful [faces](https://www.sciencedirect.com/topics/neuroscience/face) are detected more quickly during nasal inspiration (as compared to expiration) but not during oral breathing. Phase locking with spontaneous nasal inhalation at the onset of cognitive tasks improves performance in human beings. During volitionally-paced breathing the coherence between respiration and brain activity increases in a widespread network comprising fronto-parietal-insular cortices.

### Fig. 1

### Fig.58.Distribution of peak frequency ratios of Alpha Frequency (AF) to Heart Rate (HR) during task performance (top panel, green) and eyes-closed wakefulness (red and orange). The lower two panels show the ratios for Spindle Frequency (SF) and Heart Rate (HR) for sleep stage 2 (purple) and sleep stage 4 (bottom panel, blue). Plots represent individual ratios (jittered dots), probability distribution, and box-plots (median and quartiles). In contrast to task performance (top panel), during wakefulness, mean AF : HR is significantly different than the predicted coupling ratio of 8. During sleep stages 2 and 4, mean SF : HR were not significantly different from the predicted decoupling ratio of 12.94.

### Fig. 2

### Fig.59. Distribution of peak frequency ratios of Alpha Frequency (AF) to Breathing Frequency (BF) during task performance (top panel, green) and eyes-closed wakefulness (red & orange). The lower two panels show the ratios for Spindle Frequency (SF) and Breathing Frequency (BF) for sleep stage 2 (purple) and sleep stage 4 (bottom panel, blue). Plots represent individual ratios (jittered dots), their probability distribution, and box-plots (median and quartiles). In contrast to task performance, during wakefulness, mean AF : BF was significantly different from the predicted coupling ratio of 32. During sleep stages 2 and 4, mean SF : BF were not significantly different than the predicted decoupling ratio of 51.78.

### Fig. 3

### Fig.60.Distribution of frequency ratios of Heart Rate (HR) to Breathing Frequency (BF) during task performance (top panel, green), eyes-closed wakefulness (red & orange), sleep stage 2 (purple) and sleep stage 4 (bottom panel, blue). Plots represent individual ratios (jittered dots), their probability distribution, and box-plots (median and quartiles). In none of the cases did we observe a significant deviation from the predicted coupling ratio of 4. Electroencephalographic and magnetoencephalographic data have characterized two types of brain–body interactions observed during various types of motor actions, “corticokinematic” and “corticomuscular” coupling. Corticokinematic coupling (referred to as corticokinematic coherence) probes the relationship between activity of sensorimotor network nodes and various movement-related signals (e.g., speed, velocity, acceleration). It is mainly driven by movement rhythmicity during active, passive, and observed dynamic motor actions. It predominates at the primary sensorimotor cortex contralateral to the moving limb, occurs at movement frequency and its harmonics, and predominantly reflects the cortical processing of proprioceptive feedback driven by movement rhythmicity in a broad range of dynamic motor actions.

### Corticomuscular coupling (referred to as corticomuscular coherence) probes the interaction between sensorimotor cortical rhythms and electromyographic (EMG) activity that mainly occurs during steady isometric muscle contraction. The central nervous system interacts with body parts through peripheral and autonomic nervous systems. Efferent neural pathways originating from motor, premotor, as well as somatosensory neocortical areas convey the motor command through the spinal cord and efferent peripheral nerves to control voluntary limb and body movements. By contrast, afferent spino-cortical and spino-cerebellar neural pathways contribute to somatosensory perception and sensorimotor feedback for motor control. Human scalp EEG and MEG recordings have demonstrated a robust relationship between time-varying brain activity and movement velocity. “movements” refer to dynamic motor actions characterised by noticeable change in muscle length and joint angle. Using advanced source reconstruction methods and complex visuomotor adaptation tasks, MEG studies identified significant coupling between slow (2–5 Hz) neural activity at the primary motor (M1) cortex contralateral to hand movements and time-varying hand movement velocity. Continuous interactions between physiological body–brain rhythms influence how individuals act, perceive, and evaluate their environment.

### Stepping back from Descartes’ and Newton’s reductionist principles, recent research confirms that multiple physiological activities of the body and the brain share a cyclic (quasi-)periodic nature and display systematic patterns of (a)synchronous oscillatory dynamics and/or mutual dependencies. Although the body rhythms such as respiration and heart rate (HR) are slower (roughly 0.25 Hz and 1.25 Hz, respectively) than the neural rhythms (1–50 Hz) across the lifespan, empirical evidence confirms their tight link to neural and cognitive functions. Body rhythms directly influence neural spiking and oscillatory activity and modulate information processing, perception, action, cognition, and emotion regulation. The central tenet of the body–brain dynamic system (BBDS) is to regard the body and the brain as independent subsystems that dynamically transition from decoupled to coupled states in a context-specific manner. Neurophysiological activity is characterized by periodic fluctuations in the excitability of neuronal populations.

### Rhythmic oscillatory activity is clustered (with some flexibility in the bandwidths) in multiple frequency bands, ranging from delta (1–4 Hz), theta (4–8 Hz), alpha (8–12 Hz), beta (12–25 Hz) and gamma (from 25 Hz onwards). These oscillations and their relation to cognitive function have been extensively studied in the domains of attention, sensorimotor behavior, speech, and music, while aberrant neural oscillatory activity is linked to dysfunction. Neural rhythms adhere to a specific spatio-temporal organization whereby functional coupling across space, time, and frequency is associated with local cytoarchitectonic structure, specific anatomical connectivity, as well as with cognitive function. For example, the coordination of excitability changes across neuronal populations render perception an essentially rhythmic function, which depends on the phase and rate of the respective oscillations.

### Two main control systems regulate respiratory muscles. One exerts unconscious, autonomic, and continuous control of respiration meeting the body’s metabolic demands. This pathway comprises the brainstem, reticular formation, pons, and medulla. The other system, comprising sensorimotor and limbic forebrain structures, facilitates the top-down control of respiration, allowing among other functions to coordinate speech and complex motor acts. A widespread cortico-limbic network actively tracks human breathing. Activation of olfactory and limbic regions, including the amygdala and hippocampus, aligns with the inspiration phase of the respiratory cycle. Voluntary control of breathing engages primary sensory and motor cortices, the supplementary motor area, cerebellum, thalamus, caudate nucleus, and globus pallidum, bilaterally, as well as the medulla. Breathing is also modulated by covert motor behavior, for instance during imagery and listening to music. People tend to align their breathing with a perceived musical rhythm as a form of respiratory entrainment. The phase-alignment with external stimuli influences visuo-spatial and memory performance. Psychophysical states can modulate breathing. For instance, states of anxiety, depression, anger, stress, and other negative or positive emotions are linked to specific respiratory patterns and conscious control of breathing, for example, slowing, can induce changes in HR variability and in brain activity. This evidence points to an active interface of psychophysical states, breathing, and cognitive function.

### The alternation of systole (ventricular contraction) and diastole (ventricular relaxation) gives rise to the cardiac cycle and the heart rhythm. The heartbeat (HB) does not display the regularity of a metronome but rather acts more like a dynamic pacemaker driven by both sympathetic (acceleration) and parasympathetic (vagus) nerves. Under any excitement there will be much mutual action and reaction between them. Research shows that noradrenergic neurons in the locus coeruleus influence neurovascular coupling and cerebral blood flow, from health to pathology. HR modulates thalamic activity, resulting in global brain and cognitive effects ranging from emotion regulation to attention and working memory performance. Evidence further highlights a specific phase relationship between the cardiac cycle and information processing. Visual perception is modulated by HB-locked neural responses, so-called heartbeat-evoked potential (HEP). This link is bi-directional, as cognitive functions such as attention, emotional processing, and social cognition, as well as the underlying brain activity, similarly impact interoception and HEP heart is affected, it reacts on the brain; and the state of the brain again reacts.

### The influential predictive coding theory suggest that the brain predicts and attenuates responses to rhythmically regular signals to optimize resource allocation to non-predicted sensory input. The perception of sensory input oscillates at the HR, leading to the suppression of activity in response to events that fall on the low-excitability phase in the heart cycle . Alternatively, the ‘neural subjective frame’ suggests that (pre-attentive) updating of internal body states modulates self-awareness and sensation. The brain may switch attention from interoceptive to exteroceptive signals, and this transition parallels HEP modulations. Oscillations during interoception (35–110 Hz) differ from those during exteroception (1–35 Hz) in the insula, amygdala, somatosensory cortex, and inferior frontal gyrus. Exacerbated HEP modulations are observed in disease and associated with dysregulated behavior, impaired cognition, and atypicalities in brain volume and connectivity of allostatic network. These findings highlight bidirectional influences between heart activity, brain function, and behavior.

### HB accelerates during inspiration [respiration rate (RR) decreases] and slows down during expiration (RR increases). These fluctuations of HB in relation to the breathing cycle are part of the phenomenon known as HR variability and are influenced, among other factors, by the baroreflex and the sympathetic nervous system. The HR depends on breathing rhythms and tidal volume (depth of ventilation) and relates to breathing cycles approximately with a 4:1 ratio (four HBs within one respiration cycle). The brain is closely attuned to visceral signals from the body's internal environment, as evidenced by the numerous associations between neural, hemodynamic, and peripheral physiological signals.

### An analysis of the center frequency of traditional frequency bands and their coupling principles suggest a binary hierarchy of frequencies. This principle leads to the foundation of the binary hierarchy brain body oscillation theory. Its central hypotheses are that the frequencies of body oscillations can be predicted from brain oscillations and that brain and body oscillations are aligned to each other. The empirical evaluation of the predicted frequencies for body oscillations is discussed on the basis of findings for heart rate, heart rate variability, breathing frequencies, fluctuations in the BOLD signal, and other body oscillations. The conclusion is that brain and many body oscillations can be described by a single system, where the cross talk – reflecting communication – within and between brain and body oscillations is governed by m : n phase to envelope and phase to phase coupling. During periods of increased cognitive demands, cross‐frequency phase to phase coupling increases. Another basic result stems from the 1 : 2 ratio between neighboring frequencies. Center frequencies in the delta, theta, alpha, and beta band reveal a doubling/halving relationship which can be observed in power spectra in some tasks. A good example is the co‐occurrence of frontal midline theta at about 6 Hz and upper alpha at about 12 Hz which appears during increased WM demands. For any frequency domain, the next higher neighboring frequency domain is twice as fast. The ratios of all frequency domains (in ascending order), relative to the slowest domain, establish a binary hierarchy (2, 4, 8 …), but this does not mean that other harmonic ratios (3, 5, 6, 7, 9, 10 ….) do not occur.

The frequency architecture is not only defined by conditions enabling optimal phase coupling, but also by conditions enabling optimal phase decoupling to reduce interference between frequencies. Two aspects are important here. One refers to mathematical analyses which document that the golden mean (g = 1.618…..), as the ‘most irrational number’, enables the best possible frequency separation between two frequencies m and n (n/m = g;). Another aspect is that for frequency domains, frequency separation is provided (beside other factors) by non‐overlapping frequency bands. Only the binary hierarchy enables non‐overlapping frequency bands. One of the most sophisticated studies with human subjects investigated phase coupling during the retention period of a visual working memory task from combined MEG/EEG data, which were source‐reconstructed and represented on a flattened cortical surface. Cross‐frequency and 1 : 1 within‐frequency phase coupling were measured for each pair of cortical parcels and between all frequency pairs (in the theta‐, alpha‐, beta‐, and gamma frequency range). They found significant 1 : 4 coupling between high alpha (13 Hz) and gamma (54 Hz). The calculation of task‐related phase coupling (during retention relative to baseline) for all inter areal connections and frequency bands revealed an increase in connectivity for phase coupling of (high) theta and (high) alpha for most of the harmonic ratios (from 1 : 2 up to 1 : 9). Because theta and alpha were 1 : 2 related (with frequencies at 6.6 and 13.2 Hz;) and each of the two frequencies showed coupling with higher harmonic frequencies, a binary hierarchy with 6.6 Hz, 13.2, Hz, 26.4 Hz, and 52.8 Hz was observed as well as a task‐related decrease in connectivity, which was concentrated at around 8.6 Hz.

Phase synchronization of neuronal oscillations in specific frequency bands coordinates anatomically distributed neuronal processing and communication. Oscillations and synchronization take place concurrently in many distinct frequencies, which serve separate computational roles in cognitive functions. Such integration of processing between frequencies can be achieved via cross-frequency coupling (CFC), either by phase-amplitude coupling (PAC) or by n:m-cross-frequency phase synchrony (CFS). Both CFS and PAC networks coupled theta and alpha oscillations with higher frequencies in large-scale networks connecting anterior and posterior brain regions. CFS and PAC networks have distinct spectral patterns and opposing distribution of low- and high-frequency network hubs, implying that they constitute distinct CFC mechanisms. The strength of CFS networks is predictive of cognitive performance in a separate neuropsychological assessment.

Human electrophysiological activity is characterized by neuronal oscillations, i.e., rhythmic excitability fluctuations in a wide range of frequencies, at least from 0.01 to over 150 Hz. Synchronization of these oscillations, estimated as phase synchrony (PS), across brain areas coordinates and regulates anatomically distributed neuronal processing . In humans, large-scale oscillatory networks in several frequency bands characterize magnetoencephalography (MEG), electroencephalography (EEG), and stereo-EEG (SEEG) data during resting-state (RS) activity and in many cognitive functions. Interareal synchronization of alpha (α, 7–14 Hz) and beta (β, 14–30 Hz) oscillations in humans and nonhuman primates, respectively, regulate top-down or feedback communication. Both β and gamma-band (γ, 30–100 Hz) oscillations and synchronization have been associated with bottom-up sensory processing and representation of object-specific sensory information, and β oscillations are associated with sensorimotor processing. Brain-wide oscillation networks in multiple frequencies are the core of cognition. Human brain activity at rest is characterized by resting-state networks (RSNs), identified with functional magnetic resonance imaging (fMRI) . The interplay between oscillations at distinct frequencies is regulated via 2 forms of cross-frequency coupling (CFC): phase–amplitude coupling (PAC) and cross-frequency phase synchrony (CFS). PAC indicates the correlation between the amplitude envelope of a faster oscillation and the phase of a slower oscillation, whereas CFS is a form of phase synchronization defined by a nonrandom phase difference between oscillations having an integer *n*:*m* frequency ratio. Unlike PAC, CFS enables temporally precise coordination of neuronal processing by establishing systematic spike-timing relationships among functionally distinct oscillatory assemblies to serve functional integration and coordination across within-frequency synchronized large-scale networks. Local CFS has been observed in human MEG and EEG data during rest and during attentional and working memory (WM) tasks as well as in LFPs in the rat hippocampus.

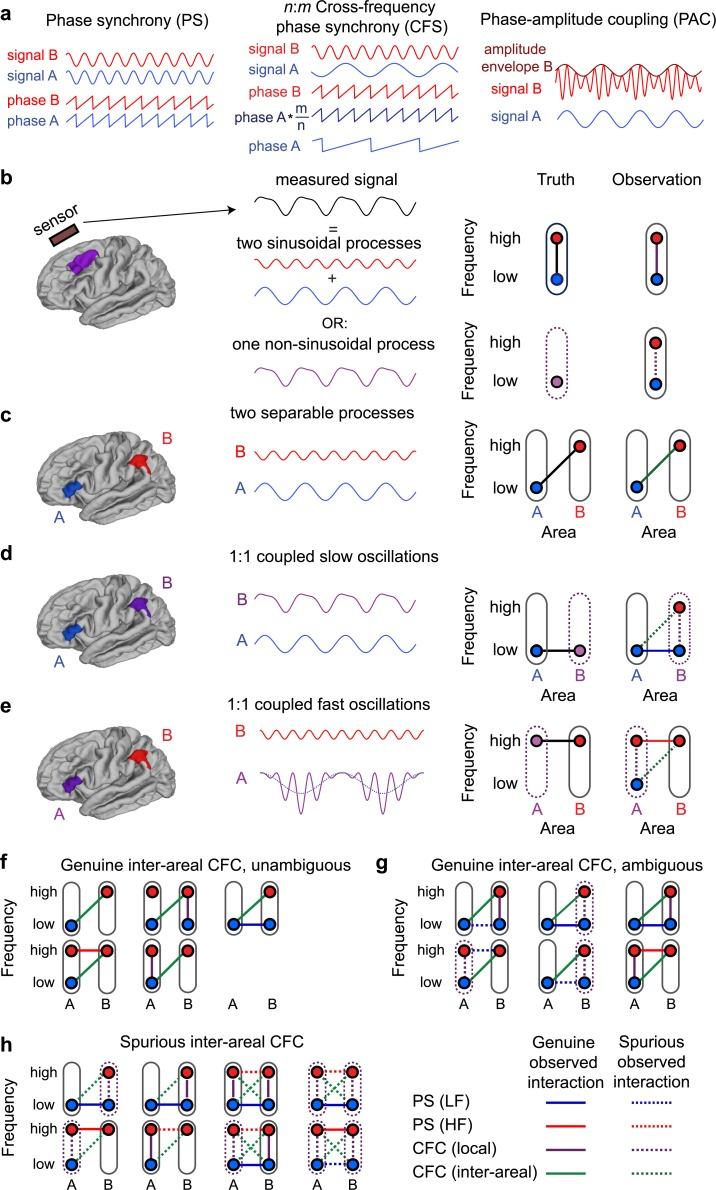


Fig.61.

1. Schematic illustration of PS, LF:HF (n:m) CFS, and LF:HF PAC. In PS, 2 spatially distant processes oscillating at the same frequency exhibit a (statistically) constant phase relationship. In CFS, a constant n:m-phase relationship exists between 2 processes at frequencies LF and HF, so that LF:HF = n:m. In PAC, the amplitude of the HF signal is correlated with the phase of the LF signal. These processes can either take place in the same region (local CFC) or between 2 regions (interareal CFC).
2. Observations of local CFC can be either genuine or spurious. A measured signal from a single sensor or electrode can either be the sum of 2 (statistically) sinusoidal processes oscillating at distinct frequencies or a single nonsinusoidal process, and these possibilities are difficult to dissociate from the single signal. Local CFC can be observed in both cases because of filter artifacts produced by nonsinusoidal signals.
3. Genuine interareal CFC between 2 spatially distant sinusoidal processes A and B.
4. An example of spurious observation of interareal CFC.

Process A is sinusoidal, but B is nonsinusoidal and causes spurious local CFC to be observed at location B, as shown in (b). If A and B are connected by LF PS, spurious interareal CFC will also be observed between A and B. This spurious observed interareal CFC forms a “triangle motif” with PS and the spurious CFC couplings.

(e) Example of spurious observation of interareal CFC in which process B is sinusoidal, but A has a nonzero mean, and spurious local CFC will be observed at location A. Again, if A and B are connected by HF PS, spurious interareal CFC will also be observed between A and B, again forming a triangle motif.

(f) Constellations of observations that unambiguously indicate genuine CFC between regions A and B. In none of the cases is there a triangle motif of PS and local CFC.

(g) Constellations of observations with ambiguous finding of interareal CFC between regions A and B. Although here, interareal CFC is genuine, it is part of a triangle motif formed with PS and (true or spurious) local CFC. Such constellations cannot be distinguished by our graph-theory–based method from spurious interareal CFC.

(h) Constellations with spurious interareal CFC. These include the 2 constellations from (d) and (e) in the left column and other possible constellations, including those in which there is spurious local CFC at both locations (right column). In all cases, the spurious interareal CFC is part of a triangle motif. CFC, cross-frequency coupling; CFS, cross-frequency PS; HF, high frequency; LF, low frequency; PAC, phase–amplitude coupling; PS, phase synchrony.

CFC indicates an interaction between 2 distinct neuronal processes in 2 frequency bands. The notion of artificial CFC arising from nonsinusoidal signal properties relies on the assumption that a neuronal process exclusively in a single frequency band generates the observed signal. Approaches based on waveform analysis and appropriate control analyses have been proposed to reduce the artifactual connections. Filter-artifact–caused spurious CFC, in particular CFS, is difficult to dissociate from genuine CFC by inspection of the waveform shape of any single signal in isolation.

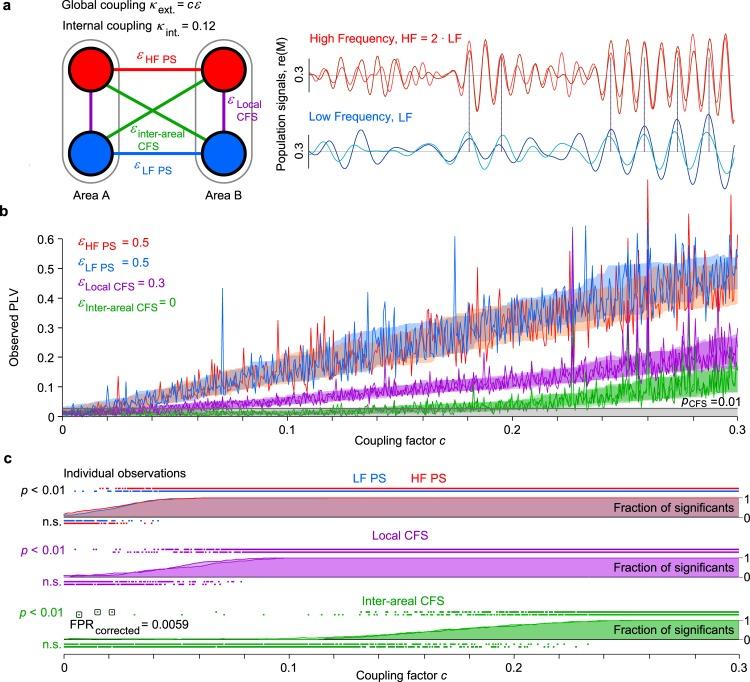


Fig.62.

1. Two areas (A and B), each containing 2 populations of Kuramoto oscillators (N = 500) at LFs and HFs. The populations exhibit intermediate and intermittent internal synchronization (see time series) and are mutually coupled by population-signal–based 1:1 PS or 1:2 CFS phase coupling (see ε).
2. Increasing the 1:1 and local CFS coupling between populations led to strengthening of the corresponding phase correlations (PLV, red and blue lines for PS and purple for local CFS) and, in the regime of strong coupling, also to the emergence of spurious interareal CFS (green lines). Each data point indicates the observed phase correlation (PLV) in a single simulation with 100,000 iterations (5,000 cycles of the fast oscillation) with random initial parameters in a series of 512 simulations for coupling factors from 0 to 0.3. Shaded areas indicate the 16th to 84th PLV percentiles across simulations. The gray line and shaded area indicate the PLV threshold for nominally significant CFS at p < 0.01.
3. Phase correlation statistics: small squares indicate significant (p < 0.01) or n.s. phase correlation observations in individual simulations in the example of series of panel (b). Lines and the shaded areas indicate the fraction of significant observations as a function of the shared coupling factor c. Black frames indicate the observations of interareal CFS that were not associated with significant local CFS and 1:1 PS and would thus remain as false positives after the correction proposed in this study. CFC, cross-frequency coupling; CFS, cross-frequency PS; FPR, false positive rate; HF, high frequency; LF, low frequency; n.s., not significant; PLV, phase-locking value; PS, phase synchrony.

### Human brain activity during rest is characterized by intrinsically correlated fluctuations in networks of brain regions, identified with fMRI. While PAC reflects the regulation of sensory information processing achieved in higher frequencies through excitability fluctuations imposed by slower oscillations, CFS, by definition, reflects a stable phase difference between coupled oscillations and is associated with consistent spike–time relationships between the neuronal assemblies in the 2 CFS-locked frequency bands. CFS necessitates the slow oscillation having a temporal accuracy in the subcycle timescales of the fast oscillation. Stable phase differences over large frequency ratios may be limited by the temporal accuracy in the cellular, synaptic, and circuit mechanisms generating the slower oscillations. Transient CFS at larger ratios has been observed during task performance . Intracortical recordings with laminar probes have shown that oscillations of different frequencies are generated differentially across cortical layers. Cognition arises from anatomically distributed neuronal processing in functionally specialized brain regions. Neuronal oscillations as measured by MEG/EEG recordings reflect the summated excitatory post-synaptic potentials of tens of thousands of coherently active neurons. Broadband MEG/EEG signals may be decomposed into narrowband oscillations using spectral analysis with complex wavelets or with real-valued filters. Either approach reveals three distinct parameters that characterize neuronal oscillations: frequency, amplitude and phase. Oscillation frequencies are determined by the physiological time constants of the relevant neuronal assemblies.

Neuronal oscillations in different frequency bands support different cognitive functions in different neuronal networks. The emergence of a unified cognitive moment relies on the coordination of scattered mosaics of functionally specialized brain regions. Converging evidence indicates that phase synchrony is involved in brain integration. Electrophysiological analyses in cats and primates have shown that the emergence of phase synchrony over widespread cortical domain correlates with the occurrence of attentive and perceptuomotor behaviours, as well as during the execution of a learning task. Analogous findings have been made in humans using electroencephalographic and magnetoencephalographic techniques.The evidence for phase synchronization as a mechanism for large-scale integration is correlative. Changes in synchronous activity can affect behaviour. The cellular mechanisms of synchronization, the interplay between slow and fast brain rhythms, and the role of parallel phase synchronization over different frequency bands constitute topics for future research. Oscillatory fluctuations of local field potentials (LFPs) in the theta (4–8 Hz) and gamma (25–140 Hz) band are held to play a mechanistic role in various aspects of memory including the representation and off-line maintenance of events and sequences of events, the assessment of novelty, the induction of plasticity during encoding, as well as the consolidation and the retrieval of stored memories. Recent findings indicate that theta and gamma related mechanisms identified in rodent studies have significant parallels in the neurophysiology of human and non-human primate memory. This correspondence between species opens new perspectives for a mechanistic investigation of human memory function.

Theta and gamma oscillations and the phase relationships between them contribute to memory-relevant coding of information ranging from objects to environmental locations and coordinate the interactions between regions required by some mnemonic processing while high frequency ‘ripples’ in the hippocampus contribute to consolidation. By regulating the precise timing of presynaptic and postsynaptic neurons, theta and gamma oscillations modulate spike-time dependent plasticity, a prerequisite for both short-term and long-term memory processes. Active short-term maintenance allows information from transient events to persist in the brain as active representations. This enables goal-directed decision making and learning to utilize and manipulate information beyond its transient sensory availability. Slow oscillations in the delta (1–3 Hz) and theta as well as faster oscillations in the beta (12–25 Hz) and gamma ranges have been associated with two major contributions during maintenance; coordinating distributed cortical representations and representing encoded stimuli and their sequence of occurrence.

In humans, the active maintenance of single item nonconfigural visual information enhances theta-synchrony between right frontal and parietal regions. Increasing the number of items to be retained during maintenance, without requiring sequence memory, appears to be associated with increased theta-coupling of bilateral frontal and temporal regions as well as regions in the visual ventral processing hierarchy. Gamma oscillations have been implicated in nonconfigural delay maintenance in humans and delayed-response tasks in nonhuman primates, and theta-gamma coherence has been correlated with successful nonconfigural maintenance. Hippocampal theta-gamma coupling has been related to non-configural multi-item maintenance in humans. Cognitive models of recognition memory distinguish between recollection-based recognition, or ‘remembering,’ accompanied by contextual information about the episode in which an item was encountered, versus familiarity-based recognition, or ‘knowing,’ which is devoid of such information. A hallmark of recollection is that different types of information such as time, location and sensory information need to be bound together despite their distribution across disparate brain regions. Theta and gamma oscillations play a key role in coordinating the long-range interactions required during recollection. Theta oscillations have been reported to be higher in amplitude during recollection than during familiarity and found to be related to making recognition decisions. Rhythmicity and oscillations are common features in nature, and can be seen in phenomena such as seasons, breathing, and brain activity. Despite the fact that a single neuron transmits its activity to its neighbor through a transient pulse, rhythmic activity emerges from large population-wide activity in the brain, and such rhythms are strongly coupled with the state and cognitive functions of the brain.

Humans possess various brain states. The brain state is affected by factors including: emotion, level of consciousness, and centrally acting drugs. Slow-wave delta oscillation (1–4 Hz) is highly correlated to slow wave sleep (SWS) or non-rapid eye movement sleep (NREM). Fast oscillation gamma wave can be detected during rapid eye movement sleep (REM). During wakefulness, beta and gamma activities are usually associated with the conscious state. Beta activity might be linked to motor function in the body, while gamma activity is linked to sensory perception. The medium frequency band oscillations are theta and alpha. Theta activity is dominant in children, drowsy adults, or during navigation. Alpha wave activity is prominent during wakeful rest with the eyes closed. These oscillations correlate with the level of consciousness and higher frequency bands correlate with a higher degree of consciousness. The diversity of brain state classification for different brain oscillations indicates the varying functions of brain oscillations. Although many states correspond to a dominant oscillation, the actual situation is that one dominant oscillation coexists with other oscillations, e.g., theta oscillation coexists with gamma oscillation. A brain state is a mixture of various oscillations with one dominant. The benefits of superior multichannel recording technology and the establishment of mathematical calculations for the phase of discrete biological signals have enabled scientists to inspect the phase relationship between brain regions. The phase relationship is revealed by calculating the synchrony level, which is the phase difference between two LFP/EEG signals. Long-range synchronization has been reported to involve multiple areas in the brain, for example, between the hippocampus and prefrontal cortex, and prefrontal cortex and amygdale. These synchronizations may promote the synaptic strength between neurons, improve communication between regions, and govern the formation of episodic memory. Phase synchronization between regions varies across brain regions and time. Synchrony between nearby regions is stronger than that among remote regions. This spatial and temporal pattern of phase synchronization manifests the dynamic diversity of brain oscillations.

Neurons are large, tree-like structures, whose axon and dendrites are capable of spanning over 1,000 mm. Such a complex structure endows neurons in distinct regions the ability to exchange information over long distances. Long-range cell ensemble phase synchronization contributes to synaptic strength. Synchronized waves in two regions with low phase lag cause the pre-synaptic cell and post-synaptic cell to fire simultaneously or with a small delay. According to the Hebbian rule, “cells that fire together, wire together” and hence, synaptic strength between two cells is strengthened. Before the emergence of long-range cortical connenctions that allow conscioussness, the early emergence of spontaneous electricakl activity in the brain is based on well shaped intermittent spontaneous oscilaltions that produce fetal movements. Three stages of voluntary movement have been differentiated: the first is preconceptual and involves an inner impulse, constituting the bottom-up component of the action; the second is where the intention is conceptual, specific and conscious; and the third is where the decision is made whether to perform the action, constituting the top-down processes. Neuronal oscillqations underlie bottom-up and top down processes by linking separate and distant brain areas involved at different levels of the network and ensuring complex and integrative functions.

The dynamics of oscilaltions underlie the mechansims of unity of conscioussnes. 40 Hz oscillation in the visual cortex correlates visual perceptive conscioussnes, thalamocortical 40 Hz oscilaltion play a majör role synchronizing the firing of separate and differentiated cortical neural populations underlying motion conscioussnes. Self conscioussnes involves gamma oscilaltions (40 Hz) carried out by dopamine dependent recurrent GABAergic neurons located in a cortical network connecting the medial frontal pre-area, anterior cingulate area, medial parietal area and posterior cingulate area. Neural oscillations, known as brainwaves, are rhythmic or repetitive neural activity at all levels of the central nervous system (CNS). Oscillatory activity originates either from individual neurons or from inter-neural interactions. At the individual neuronal level, oscillations appear either as fluctuations in resting potential or as a rhythm of action potentials, which can induce post-synaptic neuronal oscillations. At the level of neural ensembles, the synchronized activity of multiple neurons evokes macroscopic oscillations, which can be observed on an electroencephalogram. Macroscopic neural oscillations arise from inter-neuronal connections that can affect multiple neuronal firing patterns. These inter-neuronal interactions can cause oscillations at various frequency bands.

### Neural oscillatory activity can be affected by neurotransmitters. Specifically, the concentrations of certain neurotransmitters can regulate the amount of neural oscillations. For example, gamma-aminobutyric acid (GABA) levels have been shown to be positively correlated with oscillation frequencies in response to induced stimuli. A number of nuclei in the brainstem have various projections throughout the brain and can influence the concentrations of neurotransmitters such as norepinephrine, acetylcholine, and serotonin. These projection systems can affect the activity of brainwaves (e.g., alpha, beta, and delta waves) . Therefore, brain oscillations can be a useful tool for determining brain status and can be used to assess the prognosis of patients with brain disorders. The electric potentials generated by single neurons are too small to be recorded outside the scalp, and EEG or MEG activity always mirrors the summations of the synchronous activity of thousands or millions of neurons with similar spatial orientations. Neurons in a neural ensemble do not fire at exactly the same time (i.e., full synchronization). Neuronal firing is rhythmically modulated through local interactions between excitatory and inhibitory interneurons. Inhibitory interneurons play an important role in producing neural ensemble synchrony by generating a narrow window for effective excitation and rhythmically modulating the firing rate of excitatory neurons. If a large group of neurons are modulated at a common frequency, they will fire and generate oscillations at the same frequency, providing insights into brain entrainment. Oscillatory activity in groups of neurons involves feedback or feedforward connections between neurons that result in the synchronization of their firing activity. Associations between various neurons can cause oscillations among different frequencies in different situations. Both EEG and MEG have been used as neurophysiological techniques to collect data on brain activity. MEG can lead to a better understanding of the functioning of the brain due to its enhanced potential to determine the spatial source of the recorded activity.

With this technology, signal detection is practically unaffected by the conductivity and structure of the skull and scalp tissue. Compared to EEG systems, MEG systems allow higher spatial sampling resolution. Under favorable conditions, the spatial localization of current sources with whole-head MEG is on the order of 2–3 mm at a temporal resolution better than 1 ms. Scalp EEG is sensitive to both the tangential and radial components of a current source in a spherical volume conductor. MEG detects only its tangential components, and is most sensitive to activity from sulci. In contrast to MEG, EEG can detect signals both in the sulci and at the top of the cortical gyri. Therefore, MEG is sensitive to activity in more brain areas, but activity that is visible using MEG can be localized with greater accuracy . Scalp EEG methods also have restrictions in terms of measuring the neural source with high spatial precision, as the scalp form a barrier between electrodes and the neural cortex that distorts the neural signal from the neural generator to the electrode. Modern EEG systems have many more sensors than earlier systems (i.e., up to 512) and can use more robust and accurate source modeling techniques with an emphasis on time-domain signal processing. By contrast to MEG, advances in EEG recording technology (e.g., dry electrodes and high-density EEG) made it a feasible tool for detecting subjects' intentions and for neurorehabilitation in the clinical field, as exemplified by brain-computer interface (BCI) systems and closed loop neuromodulation systems.

After preprocessing, the EEG or MEG signal looks like a continuous line, resembling pink noise, that has broad spectral content and also reveals oscillatory activity. After time-frequency analysis, this noise is decomposed into various frequency band components, such as alpha (7.5–12.5 Hz), delta (1–4 Hz), theta (4–8 Hz), beta (13–30 Hz), low gamma (30–70 Hz), and high gamma (70–150 Hz) frequency bands . The most well-known frequency band, the alpha activity, can be acquired from the occipital montage during relaxed wakefulness and increases when the eyes are closed. During sleep, the EEG signal shows a transition from faster frequencies to increasingly slower frequencies such as alpha waves. Using the spectral alpha content of EEG signals, various stages during sleep can be classified Another deeply studied frequency band is the changing patterns of beta activity, which can be acquired from the sensorimotor cortex area before and during motor performance. In studies of beta-band activity, researchers have tried to detect subjects' motor intentions and motor performance time, motor learning, and motor memory consolidation and focused on biological mechanisms beyond gamma oscillations within the cerebral cortex and hippocampus associated with cognitive processes, including attention, sensory perception, and memory formation and various pathological conditions .

Neural oscillations are a cornerstone for identifying several neurological disorders; for example, excessive synchronization is observed during seizure activity in epilepsy and tremors in Parkinson's disease. Neural oscillatory activity can also be used to modulate the external devices of BCIs, in which subjects can control an external device by changing the amplitude of a particular brain rhythm. Brain oscillations have been categorized into spontaneous oscillations at rest and event-related oscillations during a task according to the circumstances of recording. Brain oscillations can also be measured during tasks such as body movement and specific cognitive activity.Evoked signals are another type of brain oscillation that has a relatively long latency from the signal-evoking event. Unlike spontaneous neural oscillations, evoked signals are recorded in response to any stimulus, including light and auditory or cognitive activity. The activity change in the beta-band frequency associated with movement is one of the most impressive changes among the characteristics of brain oscillations. In the motor cortex immediately prior to the start of movement, the beta-band amplitude is temporarily reduced and then shows a rebounding pattern after movement is terminated. It is important to note that similar brain oscillation characteristics have been reported even if subjects only imagine moving a joint. Neuromodulation increases or decreases brain cortical activity using electrical or magnetic stimulation. These stimuli can be delivered transcranially or intracortically and can affect either neuronal activity or interneuronal transmission. A closed-loop system can already detect the frequency of individual brain oscillatory activities in specific situations, such as finger tapping. By using this parameter, the stimulation frequency can be selected with repetitive transcranial magnetic stimulation (TMS) or transcranial alternative current stimulation. TMS can be a representative tool for evoking brain activity with EEG recordings, so-called TMS-EEG studies. With this technology, the connectivity between several brain regions can be explored and new insights into brain oscillatory activity can be obtained from TMS-EEG studies.

BCI is a type of closed-loop system, as this technique can monitor brain activity to determine the subject's intention using a decision algorithm based on artificial intelligence, and control external devices to perform various activities depending on the direction. A BCI platform consists of

1) a monitoring device that assesses the subject's intentions;

2) a process that analyzes multiple signals from various sensors including brain activity, which then decides whether or not to conduct the pre-programmed activity; and

3) an external device.

Brain oscillations are the best-known signal type to detect a subject's intention. Although BCI systems can also use other human signals such as electromyography, pressure sensors, and audio signals, brain signals have very high temporal resolution, which can be useful in the real-time detection of the subject's intention. In particular, P300 signals and ERD/ERS at the beta-band frequency have been reported to be closely associated with movement and attention. A BCI detects a change in P300 to determine the subject's intention to control the external device or cursor . The BCI accepts and delivers brain oscillatory signals combined with EMG to the processor. The decision algorithm in the processor determines the subject's intention through machine learning. Characterizing the information processing capacity of the human brain is a key challenge in cognitive psychology and neuroscience. Information processing refers to the cognitive ability of individuals to encounter, understand, and utilize new information by linking it to prior knowledge, instilling and , storing it in memory, and retrieving it when needed. This concept is rooted in cognitive psychology, which studies how the mind processes memory and information. The process typically involves three main stages: sensory memory, short-term (or working) memory, and long-term memory. Sensory memory captures information from the environment through the senses, allowing the brain to filter out what is deemed important. Short-term memory holds thoughts in the moment, while long-term memory retains information for an extended period. Effective information processing relies on selective attention, enabling individuals to focus on relevant information amidst distractions. Various strategies, such as "chunking" and encoding, help improve memory retention, making it easier to learn and recall information. The two models of information processing are serial processing and parallel processing. Serial processing is when only one processing task can be completed at a time. Parallel processing is when more than one processing task occurs at a given time.

A popular theory of information processing is the "stage theory." The first stage is [sensory memory](https://www.ebsco.com/research-starters/psychology/sensory-memory). The human brain experiences the world through the five senses. These experiences are information that the brain must process. During this stage, the brain decides which information is important and which is unimportant. The second stage is [short-term memory](https://www.ebsco.com/research-starters/health-and-medicine/short-term-memory), also called "working memory." This refers to a person's thoughts at the moment they experience something through the senses. The first two stages allow people to quickly interpret information. The last stage is [long-term memory](https://www.ebsco.com/research-starters/health-and-medicine/long-term-memory). This refers to information people can easily remember. Long-term memory is permanent memory. An example of long-term memory is the ability to recall the protagonists and antagonists of a novel even years after reading it. Information can be shifted from the short-term memory to the long-term memory via memorization and repetition.The human brain is heralded for its staggering complexity and processing capacity: its hundred billion neurons and several hundred trillion synaptic connections can process and exchange prodigious amounts of information over a distributed neural network in the matter of milliseconds. Such massive parallel processing capacity permits the visual system to successfully decode complex images in 100 ms and our brain to store upwards of 109 bits of information over our lifetime.

The term neural network originally refers to a network of biological neurons. More broadly, the term evokes a particular paradigm for understanding brain function, in which neurons are the essential computational units, and computation is explained in terms of network interactions. Note that this paradigm leaves aside many biological complexities, including functional contributions of neurochemical diffusion processes, glial cells, and hemodynamics . Although neurons are biological entities, the term neural network has come to be used as a shorthand for *artificial* neural network, a class of models of parallel information processing that is inspired by biological neural networks but commits to several further major simplifications.Information processing in the brain is governed by oscillatory activity. Activity oscillations in specific frequency bands (theta, alpha, beta and gamma) have been associated with various cognitive functions. A wealth of empirical findings has clearly underlined the importance of synchronized oscillatory activity, for many cognitive functions including perception, attention, learning, memory, motor control and higher-level goal-directed behavior. An emergent cognitive science framework conceptually harmonizing research on human action control and related fields—the Binding and Retrieval in Action Control (BRAC) framework  stands in the tradition of the so-called ideomotor theory .

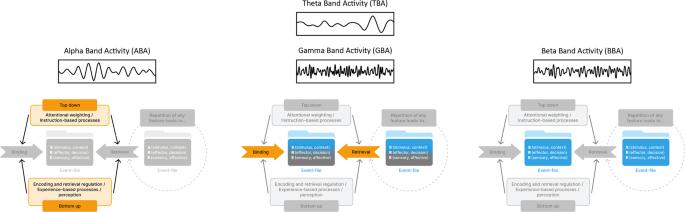


Fig.63.Oscillatory activity in the theta, alpha, beta and gamma frequency band mapped on the mechanistic structure of the BRAC framework. Alpha band activity is likely to be central for top-down (i.e., attentional weighting/instruction-based processes) and bottom-up (i.e., experience-based processes/perception) modulatory effects on binding and retrieval processes. Theta band activity is thus directly modulated by alpha band activity, because theta band activity is supposed to reflect binding and retrieval processes impinging on event-files Gamma band activity is also part of this dynamics, especially as far as the encoding/retrieval of locally bound stimulus features underlying a coherent perception are concerned. Beta band activity is thought to be essential for constituting the event-file structure and is thus subject to theta/gamma band activity effects underlying binding and retrieval processes.

Action control research is concerned with the understanding of how humans plan and execute actions. Actions are one of the most important outcomes the cognitive system can accomplish. Through actions creatures shape, influence, and interact with their environment, including other creatures[https://www.nature.com/articles/s42003-023-04531-9](https://www.nature.com/articles/s42003-023-04531-9#ref-CR10). Brain oscillations induce synchronized firing between cell assemblies which shape synaptic plasticity. Synchronized activity power increases in the Theta (around 5 Hz) and gamma (greater than 40 Hz) frequency ranges play an important role for episodic memory formation and retrieval via shaping synaptic plasticity and coordinating the reactivation of memories. Memories are stored in the synaptic weights of neural assemblies, which are shaped by synchronized activity. Neural desynchronization reflects in power decreases in the alpha and beta frequency band. (8-30 Hz.) Brain oscilaltions refer to the regular fluctuations in the local field potential , reflecting the input of thousands of neurons to a specific cell assembly. Brain oscilaltions index graded excitatory or inhibitory postsynaptic potentials can be picked up by EEG/MEG sensors. These synchronous fluctuations between excitation and inhibition induce synchronized firing patterns. Brain oscilaltions are one of the core neural mechanisms for the storage and retrieval of long term memories. Decreases in synchrony correlate with the formation and retrieval of long term memories. Such desynchronization is typically observedv in the alpha (8-12 Hz) and beta band (13-35 Hz) . Power decreases in the alpha and beta frequency bands are paralleled with concurrent power increases in the gamma frequency range. (greater than 40 Hz.).

Attention to a stimulus enhances gamma power in the receptive field while decreasing power in the alpha/beta frequency range. This negative relationship reflects the frequency shift of oscilaltory activity from lower to higher frequencies , which ocur during active cortical processing. Alpha amplitude modulations regulate information processing such as its increases reflect inhibition of task irrelevant brain regions.Understanding the dynamical neural gamma oscillation during brain state switch has been accepted as a critical step to explain attention and related [human behaviors](https://www.sciencedirect.com/topics/neuroscience/human-behavior). Experimental studies have found a specific [pulse](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/pulse-rate) of gamma power traces, coexisting with a [pulse](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/pulse-rate) of functional magnetic resonance imaging with energy consumption by utilizing intracranial electroencephalography and neuroimaging. This phenomenon implies that the gamma oscillation is crucial in the success of the attention switching process after the attention task termination.Gamma band oscillatory activity is also associated with attention. Gamma event-related synchronization (ERS) shows a close spatial correspondence to fMRI activation and is believed to reflect neuronal processing and, can be used to identify active operations within local circuits . Long-range gamma band coherence is also believed to reflect neuronal communication that subserves cognitive flexibility . Gamma activity can be modulated by lower frequency waves, such as theta or alpha waves, both of which have a relationship with the P300.Top down visual attention is a fundamental cognitive process that allows individuals to selectively attend salient visual stimuli in the environment. Empirical findings have revealed that gamma oscillations participate in the modulation of visual attention. Top down attention is the ability to deliberately filter sensory information from the environment and focus on one feature of many others. In the scope of visual attention , features like location , orientation, and object are encoded by anatomically distributed neuronal populations. Top down visual attention is a fundamental cognitive process that allows individuals to selectively attend to salient visual stimuli in the environment.

Gamma-band (25–140 Hz) oscillations are a hallmark of sensory processing in the forebrain. The optic tectum (OT), a midbrain structure implicated in sensorimotor processing and attention, also exhibits gamma oscillations. Frontal midline theta rhythm indicating focused attention.is widely distributed over medial prefrontal areas in EEG recordings, of normal subjects when performing a broad range of cognitive tasks demanding mental concentration . Brain oscillations across all frequency bands play a key role for memory formation . Specifically, desynchronization of local neuronal assemblies in the left inferior prefrontal cortex (PFC) in the beta frequency (∼18 Hz) has been shown to be central for encoding of verbal memories . Brain oscillations in a wide range of frequencies play a core role in the formation of memories by coordinating neural activity in distributed cell assemblies . Among these memory-related oscillations, a critical role seems to be played by desynchronized local neural activity in the beta frequency, which strongly correlates with episodic memory formation . A combined EEG-fMRI study localized these beta power decreases (17–20 Hz) to the left inferior frontal gyrus (IFG), consistent with a plethora of fMRI studies implicating this region for memory formation . It has been argued that decreased beta oscillatory activity might help local cell assemblies to enhance information-coding capacity and thus aid memory formation .

Neural synchronization between distant cell assemblies is crucial for the formation of new memories. Memories are thought to be stored within synaptic connections among widespread cortical network, with the strength of these connections being modified by neural synchrony. Phase synchronization establishes communication between distant brain areas, presumably shaping neural plasticity by facilitating long-term potentiation . Electrophysiological studies in humans have reported enhanced phase synchronization in memory tasks to be associated with memory formation.Phase synchronization refers to synchrony between distant brain regions as reflected in synchrony between electrode sites.

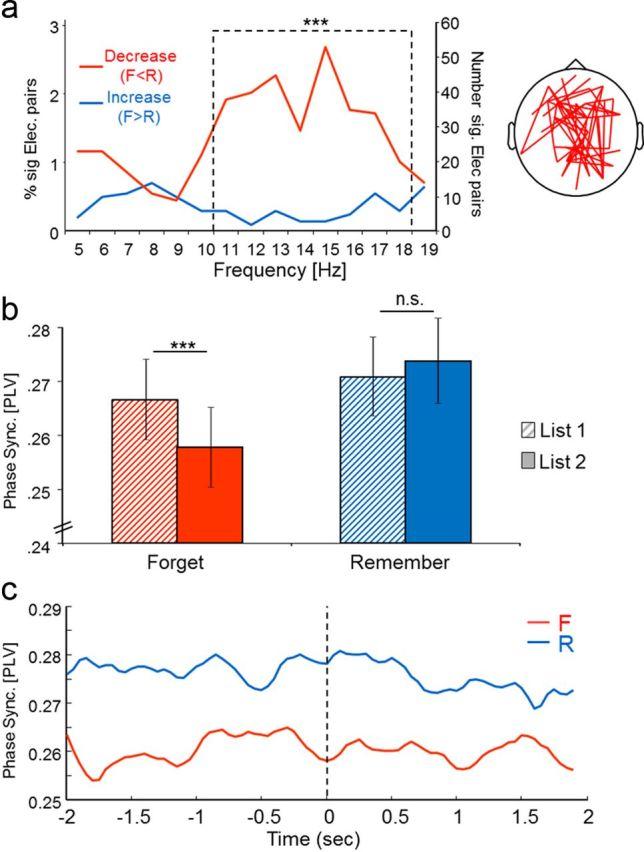


Fig.64.

**a**, Differences in phase synchronization between the Forget (F) and the Remember (R) condition are shown across different frequencies (x-axis). The number of electrode pairs showing significant differences (p < 0.005) between the two conditions (F > R/F < R) is shown on the y-axis. The left axis shows the percentage of significant electrode (sig Elec.) pairings (of all possible pairings), and the right axis shows the absolute number of significant electrode parings. A significant decrease in phase synchronization from 11 to 18 Hz in the F compared with the R condition (pcorr < 0.005) over widespread cortical regions was observed.

**b**, Mean levels of phase synchrony are shown for the F and the R conditions.. The pattern shows a decrease across the two lists in the F (p < 0.005) but not in the R (p > 0.1) condition. Error bars indicate SEs. \*\*\*p < 0.005. **c**, The time course of phase synchronization (11–18 Hz) for the electrodes showing a significant difference between the Forget and Remember conditions during List 2 encoding is depicted. Note the tonically reduced phase synchronization in the Forget condition that appears to be independent from stimulus onset.

Prefrontally regulated neural synchrony reflects an active memory control process. Following the idea that memories are represented in widely distributed cortical network, a widespread decrease in phase synchronization reflect the downregulation of the cortical network representing the obsolete, to-be-forgotten memories. The impact of oscillatory activity on memory formation has been demonstrated on the microlevel (i.e., in single-cell and multicell recordings in animals. It is now increasingly being recognized that brain oscillations, and large-scale phase synchrony in particular, play a fundamental role for human long-term memory. Prefrontally mediated regulation of long-range synchrony may be a general mechanism underlying memory control.Oscillation amplitudes reflect the extent of synchrony of neurons in a local assembly . A number of studies have observed task-related oscillation amplitude or power fluctuations across specific frequency bands , highlighting the importance of oscillation amplitudes as a marker of cognitive function. However, oscillation amplitudes do not reveal the coordination or communication of neuronal activity across brain regions. In contrast, the phase of an oscillation, which indicates the position of the signal within a given oscillation cycle, has been shown to be critical in the coordination of anatomically distributed processing . An accumulating amount of literature suggests that large-scale network synchronization is a salient and functionally relevant aspect of both brain activity and non-invasively recorded neuronal signals, for instance among EEG sensors , MEG sensors and cortical regions as obtained using source reconstruction methods . These results suggest that phase synchronization in cortical networks coordinate communication across anatomically distributed processing.

Phase synchronization and amplitude correlations are functionally independent phenomena and reveal distinct neuronal networks .The importance of phase information in neuronal processes is highlighted by studies showing that phase patterns can code for more information than amplitude in both visual and auditory processing. This points to phase as not only reflecting neuronal synchronization but also as a carrier of information between neuronal assemblies. Such phase-based information flow from one cortical area to another cannot be evaluated using phase synchrony metrics which are inherently undirected. To completely decipher the role of phase patterns in distributed neuronal processing, connectomics analyses need to be carried out using metrics that evaluate the influence of one signal's phase on another signal's phase.Communication between brain regions is fundamental to all sensorimotor and cognitive functions . Phase synchronization between neuronal oscillations from different brain regions is considered to subserve inter-regional communication by regulating the relation of spike arrival times to windows of excitability in the receiving brain region. Distinct sets of brain regions are recruited into networks of phase synchronization in tasks involving, *e.g.*, working memory , language , visual attention and sensorimotor processing . Neurophysiological studies have revealed reciprocal interactions between excitatory and inhibitory neuronal populations to underlie intra-regional phase synchronization

Humans operate in complex environments requiring the encoding and processing of a constant flow of sensory information. Neuronal oscillations, in which excitability is modulated by the phase of the rhythm, play important mechanistic roles for routing information, since they can change the dynamic interactions between brain regions on a fast time scale. Alpha oscillations are associated with pulses of inhibition every ∼100 ms and can suppress neuronal activity locally as well as support interareal communication, through phase synchronization and release of inhibition. Gamma oscillations are nested within alpha oscillations, i.e., they should occur only during the excitability phase of alpha oscillations. Beta-band oscillations play a role for coordinating the information flow by means of cross-frequency coupling, in e.g., the motor network. Cross-frequency phase coupling between alpha, beta, and gamma oscillations allow the selection and maintenance of object representations during perception and working memory. Cross-frequency phase synchrony between the fronto-parietal network and the local gamma oscillations in sensory regions underlie the incorporation of stimulus representations into the focus of attention. Brain communication, defined as information transmission through white-matter structural connections, is at the foundation of the brain’s computational capacities that subtend almost all aspects of behavior: from sensory perception shared across mammalian species, to complex higher-level cognitive functions in humans and gives rise to macroscale patterns of synchronous activity –or functional connectivity– between remote areas of the brain.

 The brain is effectively a complex system, a network of neural units interacting at multiple spatial and temporal scales through the white-matter wiring. From an evolutionary perspective, high communication efficiency at minimal structural wiring cost has long been recognized as a fundamental attribute constraining the evolution of neural systems. Structurally connected region pairs tend to have stronger functional connectivity than disconnected pairs, indicating the presence of monosynaptic interactions[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR12). Direct structural connections alone are not able to explain most of the dynamic functional repertoire observed in a functioning brain[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR13). Beyond monosynaptic interactions, functional connectivity between remote brain areas emerges from more complex, higher-order communication mechanisms that involve larger groups of neural elements and their structural interconnections, through polysynaptic (multi-step) routing of neural information. Brain networks of several mammalian and simpler species have short structural path length at the price of a relatively high wiring cost[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR5), suggesting that polysynaptic shortest paths contribute to efficient communication in brain networks and have been selected throughout evolution despite their high wiring cost. In the brain, parallel communication increases transmission fidelity, robustness and resilience to brain damage[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR1) while achieving a reasonable trade-off between communication efficiency and metabolic expenditure[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR22). Multiple communication channels may be used together or separately at different moments in time to support changing internal and external representations and complex functions including higher-order cognitionn. Specialized, unimodal brain systems are organized as serial, hierarchical streams where raw sensory information is relayed through stepwise progressive circuits to guide attention and direct actions.

Parallel communication contributes to the individual specificity of communication strategies in brain networks. Selective and parallel information transmission allowed identifying subjects in a group with significant accuracy, across different mammalian species. This indicates that the individual layout of relay information-related pathways constitutes an important fingerprint of brain organization. In humans, brain regions that tend to communicate through parallel rather than selective streams, including transmodal regions, provided the largest contribution to subject identifiability. Consistently, fMRI activity of association and default mode cortices displays larger inter-individual variability in human and non-human primates compared to lower-order regions. The role of transmodal cortices in individual identifiability is consistent with their protracted neurodevelopment and role in higher-order cognition. Humans could be better identified than non-human mammals solely on the basis of their (within-scan) parallel communication profiles. Analyses to draw any conclusions on which brain dimension (structural connectivity, functional connectivity, parallel communication among others) are the most subject-specific or most appropriate for a fingerprinting analysis per se . The brain communication gap from selective to parallel information transmission and the cortical topographies of parallel communication patterns are not explained by cross-species differences of structural connectivity architecture, statistical properties of fMRI data, or conscious (i.e., awake vs anesthetized) state. Parallel communication differences between unimodal and transmodal areas are not explained by the structural and functional connectome architecture alone. A shift of the communication regime toward more abundant and (partially) parallelized polysynaptic information transmission may support functional integration, inter-network cross-talk, and rich functional repertoires departing from the underlying monosynaptic connectivity constraints. Polysynaptic memoryless information transmission is a simple model of communication. Brain network hierarchies may confer neural signals a memory of the regions previously visited along a path, thus modifying neural communication pathways in a context-dependent manner[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR56).

The brain may be modeled through complex multi-object interactions not attributable to information transmission alone, such as synergistic or modulatory behaviors between multiple brain regions; feedback loops; local transformation (non-linear processing) of information. Biologically, more complex communication patterns may shape important features of the mammalian brain, such as cortical temporal hierarchies or receptive time windows for attentional processes[https://www.nature.com/articles/s41467-023-43971-z](https://www.nature.com/articles/s41467-023-43971-z#ref-CR61), and are worthy to investigate in future studies. Absence of relay communication (i.e., violation of the data processing inequality) may indicate absence of any communication between particular brain regions; communication limited to one single, direct structural connection (no parallel multi-step pathways); or communication through more complex information encoding mechanisms. Sensory input decoding within the highly clustered unimodal systems (diagonal entries of the parallel communication matrices) may be supported by synergistic processes within dense structural motifs.

Four different theories explain how different brain regions communicate:

1.     Synchronized neurons in the source region— an organized firing of neurons from a source region is picked up by downstream neurons. The same amount of firing, if disorganized, has less of an effect.

2.     Coherence—neurons go through cycles to fire at different points in this cycle. If a signal arrives from a different area during a point of low firing potential, it will not get picked up. But when two distant areas have coordinated cycles of low and high firing, communication between them will be strong.It takes some time to synchronize oscillations, which might not be fast enough to account for some of the brain’s more quick and flexible communication.

3.     Communication subspace— this one has to do with the specific pattern of neurons that fire. This behavior has been seen in the motor cortex, which is active without causing movement. When the pattern of neurons in the motor cortex is just right, it sends a signal to a specific muscle to move.

4.     Pulvinar-mediated communication— the [pulvinar](https://en.wikipedia.org/wiki/Pulvinar_nuclei) is a deep brain structure that receives input from many different regions of the cortex. This structure is responsible for regulating communication strength between different areas of the brain by way of one of the methods such as changing synchrony or coherence between the regions, or by activating key messenger neurons in the source area.

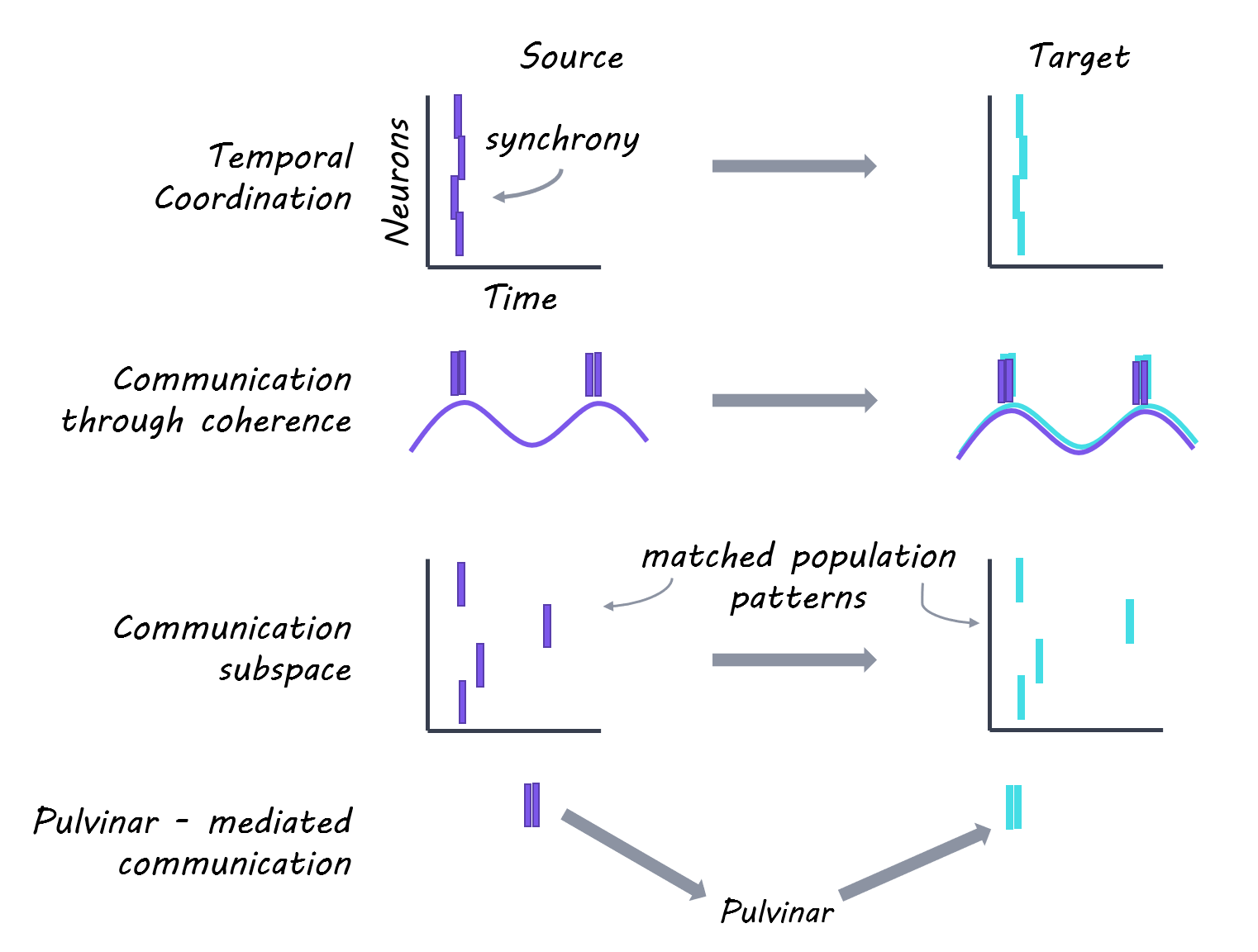


Fig. 65. Motor outputs of a nervous system can be broadly defined into those carried out by the muscles to produce movements and by the glands for secretion. Both of these behavioral and physiological events are regulated by a network of output neurons, interneurons and sensory neurons

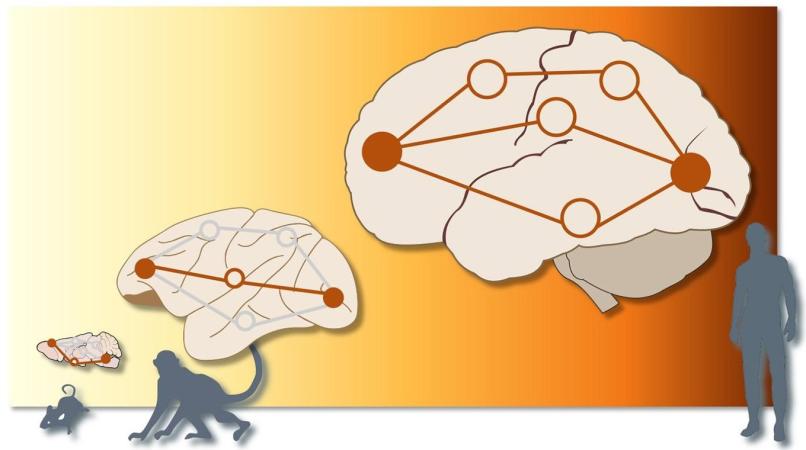


Fig.66. In the mouse and macaque brains, information was sent along a single “road”, while in humans, there were multiple parallel pathways between the same source and target. Image Credit: Alessandra Griffa CHUV/EPFL CC BY-SA

Coherent neuronal oscillations may serve as a gating mechanism for flexibly modulating communication between brain regions. For this to occur, such oscillations should be robust and coherent between brain regions that also demonstrate time-locked correlations, with time delays that match the phase delays of the coherent oscillations. Processing, transferring, and integrating information in the human brain requires effective communication.The alpha oscillation is the canonical example of rhythmic neural activity in the human brain. Alpha band activity can be distinguished from broadband activity by visual inspection alone and was the first rhythm observed and described in human recordings. Alpha oscillations play an active role in cortical functions that govern behaviors such as attention, memory, and even conscious perception. While coherence may demonstrate that two brain regions share an oscillatory rhythm, any brain regions that are communicating effectively should also share time-locked correlations over a broader frequency range. Time-locked correlated activity, which can be identified by a sharp dominant peak in the cross-correlation function, reflects a functional relationship between broadband activity of two brain regions at a consistent time delay, indicative of an effective communication channel. A critical requirement for oscillatory communication is that the phase delay between the oscillations in two brain regions can be tuned to match the conduction delay between them . Phase relationships between oscillations can be modulated.

FIGURE 6

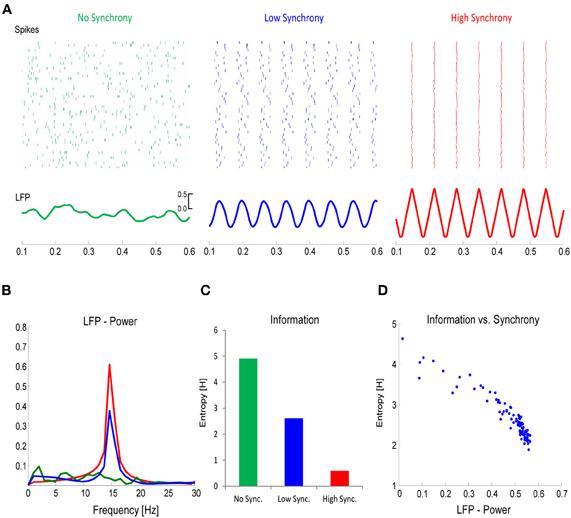
[](https://www.frontiersin.org/files/Articles/20965/fnhum-06-00074-HTML/image_m/fnhum-06-00074-g006.jpg)

Fig.67. Large-scale networks of phase synchronization are considered to regulate the communication between brain regions fundamental to cognitive function. Networks of phase synchronization are physiologically distinct from networks of amplitude correlation and exhibit different patterns of connectivity . Biophysical Network Models (BNMs), that have demonstrated the influences of local oscillatory activity and inter-regional anatomical connections in generating alpha-band (8–12 Hz) networks of phase synchronization observed with Electroencephalography (EEG) and [Magnetoencephalography](https://www.sciencedirect.com/topics/neuroscience/magnetoencephalography) (MEG) , comprise models of individual brain regions linked by biologically informed patterns of anatomical connections via finite conduction delays .

BNMs, which are a powerful tool to understand the structure-function relationship pertaining to inter-regional networks of phase synchronization, have been used to demonstrate the influences of oscillatory activity from neuronal populations , the pattern of inter-regional anatomical connections, and inhibitory [synaptic plasticity](https://www.sciencedirect.com/topics/neuroscience/synaptic-plasticity)  in generating large-scale networks of phase synchronization observed in Electroencephalography (EEG) or [Magnetoencephalography](https://www.sciencedirect.com/topics/neuroscience/magnetoencephalography) (MEG) resting-state. They have also been used to relate the heterogeneity of inter-regional conduction delays to the observed bimodal distribution in angles of inter-regional phase synchronization . BNMs specify inter-regional delays by dividing the Euclidean distance between regions with a biologically-informed but spatially uniform conduction velocity. Assuming spatially uniform conduction velocity with “distance-dependent delays” have been used to generate alpha-band (8–12 Hz) inter-regional networks of phase synchronization corresponding to those observed in MEG and EEG resting-state.

The fine temporal co-ordination in many cognitive functions requires regulating conduction velocities, to compensate for delay heterogeneity due to varying connection lengths. [Myelination](https://www.sciencedirect.com/topics/neuroscience/myelinogenesis) of neurons can regulate conduction velocities through the linear relationship between outer axonal diameter and conduction velocity . A pre-requisite for alpha-band phase synchronization is alpha-band oscillatory dynamics from individual brain regions.

Due to their high delay heterogeneity, BNMs with distance-dependent delays might be prone to the dynamical regime of amplitude death, *i.e.*, cessation of oscillations . Phase synchronization cannot occur in regimes of amplitude death due to absence of oscillations. Distance-dependent conduction delays predict long inter-regional delays between spatially distant brain regions. These long delays might be deleterious to inter-regional communication through phase synchronization, particularly when the lag of phase synchronization is close to the oscillatory time period. Modeling studies have demonstrated several means by which phase synchronization lags might be adjusted, enabling rapid inter-regional communication despite long conduction delays. For example, the presence of a common relay region between two interacting regions , driving currents , or local inhibition can adjust the lag of phase synchronization towards zero. Temporally precise inter-regional communication can occur despite the presence of long inter-regional delays.

Neuronal activity in sensory and fronto-parietal (FP) areas underlies the representation and attentional control, respectively, of sensory information maintained in visual working memory (VWM). Within these regions, beta/gamma phase-synchronization supports the integration of sensory functions, while synchronization in theta/alpha bands supports the regulation of attentional functions. A key challenge is to understand which mechanisms integrate neuronal processing across the distinct frequencies and the sensory and attentional functions. Working memory (WM) has a limited capacity of 3−4 objects and is comprised of sensory storage and central executive control for manipulating the stored information and supporting the preparation of a contingent . During visual WM (VWM) maintenance, these functions are achieved in visual and fronto-parietal (FP) brain areas, which exhibit enhanced neuronal activity levels during memory maintenance in both monkey single- and multi-unit recordings and functional MRI (fMRI) of humans . While the visual cortex is responsible for the processing of visual information and its maintenance in VWM , lateral prefrontal cortex (LPFC) regulates VWM maintenance, represent goals and rules, and govern response selection . Studies show that even in primate prefrontal cortex, these VWM functions are achieved in multiple dissociable. Phase synchronization (PS) is a mechanism for integrating anatomically distributed processing and regulating the communication between distant assemblies . Human intracranial EEG (iEEG) data have revealed long-range phase-synchronization in theta (θ, 4–8 Hz), β, and γ bands in hippocampal memory circuits.

The amplitudes of both β- and γ-band oscillations are positively correlated with the task performance and individual capacity limits and support the neuronal representations of VWM contents . In contrast, the plateau of load-dependent strengthening in α-frequency band amplitudes during VWM is negatively correlated with the individual VWM capacity and α oscillations are stronger for distractors than memorized items. These findings suggest that θ and/or α oscillations underlie the attentional functions of VWM by facilitating the processing of relevant and/or by suppressing irrelevant information .Studies have shown that during VWM maintenance, γ oscillation amplitudes are coupled to θ phase via PAC in cortical and hippocampal recordings. However, PAC is independent of the phase of the fast oscillations and cannot promote a consistent temporal and spike-time relationship between the slow and fast oscillations. PAC has been suggested to underlie cross-frequency coupling of slow and fast oscillations. Phase amplitude coupling can be observed between frequencies that represent binary multiples. Different frequency oscillations have different contributions to brain function and cross frequency coupling (CFC) has been found to exist within brain regions. Seizures originate from epileptic networks in which combination of multiple neurons can trigger seizures from multiple locations and evolve into stereoscopic , macroscopic seizures.When an abnormality occurs in one node of the brain network , the area with which a connection exists is affected and eventually the subnetwork or even the whole network is disrupted.

EEG PAC, where the amplitude of high-frequency oscillations (HFOs) is modulated by the phase of low-frequency oscillations (LFOs), is a useful biomarker to identify the activities of epileptogenic tissue. Cross-frequency push-pull dynamics contributed to the secondary generalization of focal seizures and potentially reflected impaired excitation-inhibition interactions of the epileptic network. PAC feature of ictal EEG is used to determine the region of interest in epilepsy. The coupling phase is suggested as an interictal marker of the seizure-onset zone (SOZ) .The PAC in the inter- and pre-seizure periods was weak and paroxysmal, and strong PAC channels were confined more to the SOZ and resection region. The theta—gamma PAC within the electrodes in the seizure region increased during the ictal period . In Parkinson’s disease, the HFO (100–300 Hz) was found modulated by beta (13–30 Hz), and beta and gamma amplitudes were further modulated by their low-frequency components. Studies have shown that cross-frequency coupling (CFC) plays a functional role in physiological functions, such as memory, and task performing.

Convolutional neural networks (CNN) achieves automatic extraction of local features through its key component convolutional kernel and obtains high-level abstract features after a series of hierarchical processing. It may avoid the problems of manual optimizing of traditional signal processing algorithms. Cross-frequency coupling reflects non-linear interactions between signals of different frequencies. Evidence from patient and healthy paticipant studies suggest that CFC plays an esential role in neuronal computation, interregional interaction and disease pathophysiology. Electrophysiological systems such as the brain or heart generate oscillatory activity over a spectrum of frequencies. System outputs such as movement or cognitive process reflect a complex and nonlinear integration of oscillatory neural population activity This can be accessed using a range of approaches including invasive local field potential or electrocorticogram recordings, or non-invasive measures with either electroencephalography (EEG) or magnetoencephalography.

Multiple neural oscillations across temporal and spatial scales participate in neural information processing .Low-frequency oscillations control long-range synchronization, while high-frequency oscillations (HFOs) are linked to local computation.Oscillatory neural activities in multiple frequencies are modulated during a range of tasks (e.g., cognitive tasks), brain stimulation techniques that entrain (or alter) oscillatory activity are known to impact task performance. This led to the belief that oscillatory neural population activity has a causal impact on behavior and neurophysiological oscillations may serve as a biomarker for pathophysiological states such as Parkinson's disease.One particular type of oscillatory coupling, known as cross-frequency coupling (CFC), has gained great interest in medicine and neuroscience. CFC characterizes interactions across different frequency rhythms and is modulated during both physiological processing and pathological states, such as spasticity . CFC denotes the statistical association between the phase, amplitude, or frequency of 2 rhythms. CFC applied on simultaneous recordings from different cortical areas reveals a coordinated information exchange in cognitive, sensory, and motor events from long distance to local computation . Standard phase-amplitude CFC analysis proceeds by first selecting two frequency bands followed by the computation of some index for the correlation or dependency between the phase of one band and the amplitude of the other . The two components entering a phase-amplitude CFC analysis after filtering the signal, are determined by the center frequencies and bandwidths of the filters used to isolate them.

Most neuronal signals that we measure are non-stationary. Time-varying sensory stimuli, top-down influences, neuromodulation, endogenous regulatory processes and changes in global physiological states render neuronal dynamics non-stationary. In contrast to a stationary process, a non-stationary process in general exhibits spectral correlations between components of its Fourier expansion. In the non-stationary case, there are two possible scenarios leading to positive CFC measures: One scenario is that physiological processes interact. This interaction then leads to nonstationarities, and at the same time spectral correlations are observed in the Fourier representation. For example, if the phase of a neural input oscillating at theta frequency modulates the amplitude of local gamma oscillations, both obtained from the same LFP recording, the statistical properties of the gamma oscillation amplitude series will change in time, as does theta phase. Specifically, their properties will vary in time only to be repeated after a full cycle of the slow oscillation, and thus exhibiting a particular type of non-stationarity called cyclo-stationarity .

The other scenario is that unspecific non-stationarities ( any kind of change of the statistical properties of the signal), not related to or caused by coupling of neural processes, will also be reflected in spectral correlations which could be over-interpreted as the result of causal interactions among frequency specific neuronal processes. This second scenario can occur if nonstationary input to a given area simultaneously affects the phase of a low frequency component and increases high-frequency activity (common drive to different frequency components of the same signal). For example, typical evoked potentials affect a broad range of frequency components . In this case, high-frequency amplitude increases occur preferentially for certain phases of slow oscillations even without any need of interaction between the two rhythms. Non-stationary input to a given area can generate correlations between bands, which are not necessarily a signature of interactions between these bands.If a brain area under a recording electrode receives time-varying input from any other brain area, this input may generate similar dependencies across frequency components. If this internal input leads to an increase of phase locking for lower frequencies and at the same time elicits an increase in power at higher frequencies phase-amplitude coupling will be observed .

The combination of increased activity at highfrequencies and phase-locking to the stimulus of lower frequencies is sufficient to obtain significant measures in standard CFC analysis. Phase-amplitude coupling measured anywhere in the brain can be potentially explained by common influence on the phase and amplitude, without the phase of a low frequency oscillation modulating the power of high frequency activity. The key issue is to distinguish whether the observed phase-amplitude correlation between two bands is due to common drive, generated by external or internal input or whether due to a causal interaction between rhythms (which, could be triggered by the input). Analysis of between-channel phase-amplitude coupling is the result of a driving input to a single area. The current phase-amplitude (CFC) measure is constitutive for the non-stationary responses of driven systems and is not a very specific marker of biophysical coupling. From a mathematical perspective the key aspect is that any consistent response to input, whatever its shape, implies a certain phase locking between its different Fourier components . If the power of any of the fast components lasts a bit more or a bit less than the period of a slow component, its amplitude will accumulate preferably at certain phases of the slow component. This is all that is needed to give rise to phase amplitude CFC, as measured for example by the modulation index. Since the power of bands directly influences the range within which they can modulate or be modulated, it is possible that changes in CFC correlations are a direct consequence of changes in power spectra. For example, changes in the observed CFC can have their origins in the fact that power changes affect the signal-to-noise ratio of phase and amplitude variables and their correlations. It is thus necessary to control whether correlations between CFC and other behavioral or physiological variables might be simply due to changes in, for example, the strength or frequency of oscillations.

Phase synchronization play a number of different roles in brain function. Same-location, cross-frequency phase coupling may serve as a potential mechanism to regulate communication between different spatiotemporal scales. Phase-phase CFC provides a plausible physiological mechanism for linking activity that occurs at significantly different rates. Phase-amplitude CFC, has functional correlations and plausible physiological mechanisms. Low frequency phase reflects local neuronal excitability, while high frequency power increases reflect either a general increase in population synaptic activity (broad-band power increase) or the selective activation of a connected neuronal subnetwork (narrow-band power increase). Across a wide range of phase and amplitude frequency pairs, theta/high-gamma phase-amplitude CFC is strongest. Phase-amplitude CFC exists but is unrelated to functional activity, computation or communication. Low frequency activity can be entrained by rhythmic external sensory and motor events, as well as internal cognitive processes related to learning and memory. Therefore, low frequency phase entrainment combined with the presence of phase-amplitude CFC implies that the modulation of high-frequency power by CFC will be entrained and coordinated with the occurrence of slower, behaviorally-relevant internal and external events. Cross-frequency coupling (CFC) refers to the non linear interaction between oscilaltions in different frequency bands and rather ubiquitous phenomenon that has been observed in a variety of physical and biophysical systems. In particular the coupling between the phase of slow oscilaltions and the amplitude of fast oscillations, referred as phase-amplitude coupling (PAC) .Brain oscillations of different frequencies can coexist and influence each other. A cross-frequency interaction occurs when a feature from one oscillation (i.e., instantaneous amplitude, phase, or frequency) depends on a feature from another oscillation at a distinct frequency. These phenomena have been collectively called cross-frequency coupling (CFC )

Brain rhythms - as recorded in the local field potential (LFP) or scalp electroencephalogram (EEG) - play a critical role in coordinating brain networks. By modulating neural excitability, these rhythmic fluctuations provide an effective means to control the timing of neuronal firing . Oscillatory rhythms have been categorized into different frequency bands (e.g., theta [4–10 Hz], gamma [30–80 Hz]) and associated with many functions: the theta band with memory, plasticity, and navigation ; the gamma band with local coupling and competition , gamma and high-gamma (80–200 Hz) activity have been identified as surrogate markers of neuronal firing , observable in the EEG and LFP.Lower frequency rhythms engage larger brain areas and modulate spatially localized fast activity . For example, the phase of low frequency rhythms has been shown to modulate and coordinate neural spiking via local circuit mechanisms that provide discrete windows of increased excitability. This interaction, in which fast activity is coupled to slower rhythms, is a common type of cross-frequency coupling (CFC). This particular type of CFC has been shown to carry behaviorally relevant information (e.g., related to position , memory, decision making and coordination. CFC has been observed in many brain areas and linked to specific circuit and dynamical mechanisms. The degree of CFC in those areas has been linked to working memory, neuronal computation, communication, learning and emotion and clinical disorders, including epilepsy. Information processing in the brain rely on the convergence and divergence of oscillatory behaviors of widely distributed brain areas. This information flow is captured in its simplest form via concepts of synchronization and desynchronization and related metrics. More complex forms of information flow are transient synchronizations and multi-frequency behaviors with metrics related to cross-frequency coupling(CFC) that plays a crucial role in the organization of large scale networks and functional integration across large distances.

All biological systems exhibit significant non-linear behavior nature that is imminent in electrophysiological brain activity as measured by EEG or MEG and results in characterisitcs such as multistability, bifurcations, determinisitc chaos and multiscale behaviors. Even at rest (in the absence of an explicit task) the human brain shows temporally coherent activity of high degree complexity, so called resting state. Its coupling dynamics can be captured at different scales (from a single cortiğcal area to multiple cortical areas and whole brain dynamics) and frequencies using both neuroimaging techniques (fMRI and PET) and EEG/MEG recordings of complex signal containing different frequency components interacting with each other. Classic power spectral analyses based on (fast) Fourier Transform (FFT) or different time-frequency transforms (e.g. wavelet, Hilbert or Gabor transform) display amplitude modulations within the defined frequencies across time. Corresponding complex transformations of the signal provide information about phase changes but they fail identifying the relationships among different frequencies or frequency components. The cross-frequency coupling (CFC) are the carrier mechanism for the interaction of local and global processes between between different frequency bands related to the integration of distributed information.Bispectral analysis was first introduced by geophysicists in the early 1960,s, to study the interfrequency coupling of geophysical signals. These algorithms have been used in neurosciences especially in EEG. Neurophysiological evidence suggests that oscillations in theta and gamma banda re simultaneously modulated during perception and memory as well as neuronal computation, communication and learning.

Using intracranial recordings in human epilepsy patients,:

1.Simultaneous maintenance of multipkle items in working memory is accompanied by theta –gamma phase amplitude CFC in the hippocampus

2. maintenance of an increasing number of items is associated with modulation of beta/gamma power by lowering theta frequency phase.

Modulating influence of the lower theta phase on the beta/gamma activity provides for higher working memory load. Besides the cross low frequency/high frequency coupling (e.g. theta-gamma) , there is evidence that CFC exists also between the low frequency bands (e.g. delta-theta, delta-alpha and theta-alpha). An increase in upper alpha/theta phase synchronization was found between right posterior and left anterior sites in a memory scanning task.In a competitive decision making task, alpha and beta amplitude in human medial frontal cortex was modulated by delta and theta phase. The strenght of thsi modulation differed between losses and wins so that this phase amplitude coupling may reflect a coding mechanism of feedback valence information. Taking into account the main characteristics of the signals, six different CFC measure smay be obtained: Power to power, phase to phase, phase to power, power to frequency, phase to frequency and frequency to frequency. These CFC measures reflect different aspects of CFC and give a relatively complete Picture about cross-frequency interdependencies within and between the signals.

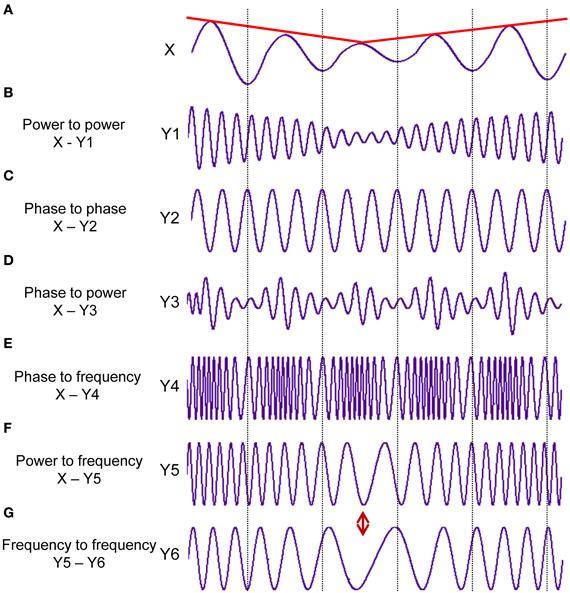


Fig.68. **Different types of the cross-frequency coupling.**

* 1. Signal *X* at a given constant frequency fluctuating in the amplitude over time (red line).
  2. Power to power CFC: Signal *Y1* at about 5 times higher frequency than in the signal *X* showing slow amplitude modulations over time like signal *X* (red line).
  3. Phase to phase CFC: Signal *Y2* showing 3:1 phase to phase coupling with signal *X*. One oscillation period of signal *X* corresponds to three periods of signal *Y2*.
  4. Phase to power CFC: Signal *Y3* with fast amplitude modulations, which are related or coupled with the phase of the signal *X*.
  5. Phase to frequency CFC: Signal *Y4* with frequency modulations, which are coupled with phase changes of signal *X*.
  6. Power to frequency CFC: Signal *Y5* with frequency modulations, which are coupled with the slow amplitude modulations of signal *X* (red line).
  7. Frequency to frequency CFC: Signal *Y6* with slower frequency modulations than in the signal *Y5*. The different types of CFC are not mutually exclusive

*Power to power CFC* indicates how amplitude modulations in one frequency depend on amplitude modulations in the other frequency. This type of CFC has been developed to investigate coupling between different high-frequency oscillations (e.g., beta, gamma) showing similar (low-frequency) amplitude modulations. The advance of this technique consists in detecting not only coupling between different frequencies but also coupling within the same frequency, which could not be found using conventional coherence measures because of large temporal or phase jitter

*Phase to phase CFC* is a measure for *n*:*m* synchronization and shows the degree of the true phase coupling between the frequencies within and between the signals. This type of CFC is a pure phase coupling measure and is amplitude-independent. This so-called *n*:*m* synchrony indicates phase locking on *n* cycles of one oscillation to *m* cycles of another oscillation. The phenomenon of phase synchronization is a characteristic feature of autonomous continuous-time system. The phase synchronization and especially the cross-frequency phase synchronization is an excellent candidate for neural temporal coding supporting dynamic information flow in the brain.

*Phase to power CFC* reflects amplitude modulations in one frequency. Like the cross-frequency phase synchronization, also the phase to power CFC is a good candidate for the neural temporal coding, with the difference that (and especially when) specific amplitude modulations (normally high-frequency modulations, e.g., gamma) of one oscillation take place in specific time windows or phase state of another oscillation (normally low-frequency oscillation, e.g., theta). Moreover, in terms of neural coding, it can be considered as an integration mechanism between the two types of coding (i.e., rate and temporal code), whilst amplitude modulations represent the rate coding and phase course. The phase of ongoing alpha oscillation, inhibiting neuronal processing, modulates neuronal excitability in form of gamma activity in the way that neural firing and corresponding gamma amplitude modulations occur during the falling phase of alpha oscillation. So, it is assumed that “alpha activity provides a clocking mechanism that controls neuronal processing reflected by activity in the gamma band.

*Power to frequency CFC* indicates changes in the frequency induced by changes in the amplitude of the signal or envelope. Instantaneous frequency (IF) is defined in this case as the phase changes in time. These signal modulations or coupling types cannot be detected by other CFC measures but they seem to play a crucial role in the systems with high dynamic changes, which can only be explained by frequency/phase entrainment. Furthermore, amplitude-frequency modulations can be attributed to so-called auto resonance, when change in the drive frequency causes a corresponding change in the oscillation amplitude, which leads to entrainment or sustained phase locking of the driving and the oscillator frequency. It is also well known that the frequency modulation as compared with the amplitude modulation allows a higher dynamic range of the information signal and is less susceptible to interference or disturbances.

*Phase to frequency CFC* indicates changes in the frequency induced by the phase of the signal. This type of CFC has a high scientific relevance adding further important information regarding CF interaction.

*Frequency to frequency CFC* reflects changes in the one frequency range induced through changes in the other frequency range. This type of CFC can provide additional information about interacting systems or cell assemblies and extend our understanding of the cross-frequency neural communication.

The network nodes of a full brain network are neural mass models derived from neuron interactions using a meanfield approach in which explicit structural features or temporal details of neuronal networks (e.g. spiking Dynamics of single neurons) are irrelevant for the analysis of complex mesoscopic dynamics and the emergent collective behavior is only weakly sensitive to the details of individual neuron behavior. Basic mean field models capture changes of the mean firing rate whereas more sophisticated mean field models account for parameter dispersion in the neurons and the subsequent richer behavioral repertoire ogf the mean field dynamics. These approaches demonstrate a relatively new concept from statistical physics that macroscopic physical systems obey laws that are independent of the details of the microscopic constituents they are built .Neuronal cell assemblies oscillating synchronously at different frquencies provide an efficient basis for integrative processes in the brain. Separate cell assemblies communicate with each other to integrate single information flows into a common network. Non linear dynamic system theory teaches us that time scale separation, which is frequency separation in this context ,offers a natural means in non-linear systems to separate information flows. CFC allowing accurate timing between different oscillatory rhytms, may be an underlying mechanism of the re-integration of these separated information flows or allowing for a communication between different cell assemblies. Information flow typically involves multiple sites of specialized processing. CFC can provide a framework for both local and distributed information processing within neural networks, serving the coordination of neural oscillations over multiple spatial scales. Disturbances of information processing in certain neurological disease states may be inferred through the observation of changes in CFC relative to healthy control populations. Findings have shown that stronger coupling tends to occur with higher neural computational needs. For example, during sleep, PAC coordinates various brain rhythms and varies across cyclic alternating patterns (CAPs). CFC plays a special role in regulating performance in cognitive and memory tasks. Oscillations in both the *θ* (5 to 8 Hz) and *γ* (30 to 150 Hz) bands display modulations in such tasks.

Studies exploring the relationship between oscillatory activity and gait have revealed that low-*γ* frequency oscillations in the motor cortex are modulated by the gait phase and central midline sites. In PD, gait phases are known to associate with modulations of *α*/*β* band activity within the pedunculopontine nucleus (PPN) . Referenced to other biomarkers, such as band power, evoked compound action potential and abnormal synchrony, CFC may offer a deeper understanding of the underlying entangling oscillatory mechanisms of neurological disorders. By identifying the interested CFC patterns that are disrupted by changing physiological or pathophysiological status, researchers can gain insight into the affected neural circuits, which could facilitate the development of more targeted and effective interventions.Cross‐frequency coupling is analyzed in epilepsy patients from intracranial EEG recordings in the hippocampus during a visual WM task and was found that increased coupling (during maintenance relative to baseline) was largest between 7 Hz theta phase and 28 Hz beta/gamma amplitude whereas coupling between delta (1–4 Hz) phase and beta amplitude (14–20 Hz), did not increase during maintenance. In  [Amplitude (envelope) coupling](https://pmc.ncbi.nlm.nih.gov/articles/PMC6668003/#ejn14192-sec-0004), hippocampal theta, that plays an important role for spatial memory, represents a memory‐related frequency domain. Single‐trial analyses demonstrate that frequencies in the theta and extended alpha frequency range (of up to 15 Hz) exhibit significant phase locking during a short‐time. The higher frequencies do not exhibit harmonic ratios relative to each other. A possible interpretation is that the phase of the slow frequency (transiently) drives the phases of higher frequencies which are (frequency) decoupled relative to each other. Phase plays a crucial role for coupling and can establish its impact – physiologically as well as mathematically – only, if a single oscillation is the dominant frequency in the analyzed band. The dominant oscillation may exhibit a large jitter in a broad band, as for example, is the case for hippocampal theta. However, in a broad band with different oscillations, the phases of different frequencies will tend to cancel each other. Thus, the critical role of phase for cross‐frequency coupling can be taken as strong evidence for the existence of distinct center frequencies.

For longer time periods, phase coupling is optimal and stable only for harmonic frequency ratios. This fact and the observation that neighboring center frequencies of traditional EEG bands exhibit a 1 : 2 ratio suggests a binary hierarchy of frequency domains. The term *frequency domain* is used to emphasize that (i) frequencies of traditional frequency bands are 1 : 2 related and (ii) reflect cognitive processing domains. Frequency domains establish a binary hierarchy relative to each other but are harmonically related to other frequencies at ratios that do not belong to the subset of binary multiples. The requirement for a harmonic frequency relationship does not apply to phase coupling in very short‐time windows. A transient and brief phase coupling between many frequencies can occur during a short‐time window. Decoupling also plays an important role as the prediction of the bandwidth of traditional frequency bands shows. All frequency domains in the binary hierarchy are functionally equal in a sense that their frequency jitter (relative to frequency) remains the same for all frequency domains. But in absolute terms (i.e., in terms of time), jitter increases with decreasing frequency. Frequency jitter is not just noise, but can be explained by cycle to cycle fluctuations in (instantaneous) amplitude and (instantaneous) period . Research on rat hippocampus gamma oscillations has shown that instantaneous amplitude and period (frequency) change rapidly and vary together. Amplitude size predicts period (frequency) in a way that (within each cycle) an increase in instantaneous amplitude is closely associated with a lengthening of the immediately following period, and – vice versa – a decrease in amplitude is associated with a shortening in the immediately following period. This kind of cycle to cycle fluctuations is manifested by a significant positive correlation between amplitude and period, which was also found for alpha oscillations in the human EEG .

The global wave model assumes that the modulation density of action potentials is a function of cortical background excitability and inhibitory feedback strength. Quantification of this model predicts that an increase in parameter β (reflecting the degree of cortical background excitability) is associated with an increase in oscillatory amplitude but a decrease in frequency. EEG/MEG signals stem from different sources in the brain. Frequencies in the delta, theta, alpha, beta, and gamma range play a primary role for long‐range connectivity and have their primary sources in the cortex. Frequency jitter (due to fluctuations in instantaneous period) is not simply noise but instead the result of a physiological mechanism that controls the relationship between excitation and inhibition. The binary hierarchy describes a frequency relationship between any frequencies regardless of their numerical values. It represents an universal scale‐free power law. One central aspect of this phenomenon is that three body oscillations, BF, HRV (i.e., the RSA peak in HRV) and BP become phase locked (although with different delays) with the same frequency at around 0.1 Hz. HR (at around 1 Hz) exhibits a clear 10 : 1 frequency ratio relative to the frequency of BF, BP, and HRV which are phase locked to each other. This harmonic relationship invites a phase coupling with HR .

Proper breathing is important for health. Incorrect or dysfunctional breathing has adverse effects on health. Correction of dysfunctional breathing through breathing therapy reduces symptoms and improves the health of patients with conditions such as asthma, anxiety, speech disorders, chronic muscular skeletal dysfunction and medically unexplained physical symptoms.Dysfunctional breathing can occur in at least three dimensions: biochemical, breathing pattern and breathing related symptoms. At least three different aspects can be distinguished, one referring to energy demands, another to resonance properties, and another to emotional changes. Resonance frequency breathing represents a state, where blood oxygenation and energy demands for blood transportation are most efficient. The reduced energy demands are reflected by the decrease in HR and the antiphase BP phase locking. The length of the delay in the baroreceptor loop is frequency locked to breathing and HRV (RSA). Mathematical models suggest that resonance frequency is critically determined by the properties of feedback loops between the heart and brain and its frequency is around 0.1 Hz. These are also dependent on body size, or more accurately, on total blood volume. Resonance frequency varies between subjects. 0.1 Hz waves do not belong to the binary hierarchy. The tight coupling between three 0.1 Hz waves (BF, HRV and BP) and the 1 : 10 ratio with HR, implies a decoupling from the binary hierarchy. Because the binary hierarchy reflects a system for optimal coupling between brain and body oscillation, resonance breathing is a state, where body oscillations are entrained to the resonance properties of the cardiorespiratory system, but are only weakly coupled with brain oscillations.Another described body oscillation is the gastric basal rhythm, which is continuously and intrinsically generated in the stomach. It has a frequency of 0.5 Hz that can be recorded with the Electrogastrogram (EGG). A special type of event‐related EEG response that reflects body–brain communication is the heartbeat‐evoked potential (HEP). It is an evoked potential, calculated time locked to the R peak which is used in research on interoceptive awareness. Proceeding from the hypothesis that the gastric basal rhythm may influence resting state brain dynamics, phase amplitude coupling between gastric waves and alpha amplitudes, gastric phase accounts for about 8% of alpha amplitude fluctuations. Directionality analyses suggest an ascending influence from the stomach to the brain. A brain network (termed gastric network) is phase synchronized with the gastric basal rhythm. Within this gastric network, approximately 15% of the BOLD variance is explained by gastric phase.

Muscle activity comprises a wide range of oscillatory components. Muscle frequencies are phase locked to the phase of EEG frequencies and limb resonance frequency is an important factor for the motor frequency architecture. Muscle activity is monitored by the use of electromyography (EMG). The EMG primarily reflects properties of motor unit action potentials. Frequency analyses show a flat double ramp‐like shape of the spectrum, with an ascending part up to a broad mean frequency range of about 40–70 Hz, which is followed by a descending part in a high frequency range that extends to several 100 Hz. The fact that the EMG has dominant power in the gamma frequency range plays an important role for the evaluation of muscle artifacts, when analyzing EEG/EMG gamma activity. Shifts in EMG mean frequency are considered valid indicators of muscle fatigue. An increase in fatigue is reflected by a downward shift in the EMG frequency spectrum, which is characterized by a relative decrease in amplitude in the higher frequency range and a small increase in the slow frequency range. The shape of the EMG spectrum is influenced by a variety of factors, primarily by the type of muscle, task, and recording (surface or needle electrodes). In the gamma band coherence is found for contraction and movement tasks. But in the beta band, coherence may be abolished during movements. During actual movement, rhythmic busting of the EMG signal can be observed in slower frequencies from delta to slow beta. This is another example of an amplitude envelope modulation by slower frequencies (e.g., in the alpha frequency range, or in the delta range). The frequency range from slow beta down to delta overlaps with the frequency range of physiological and pathological tremor, that is defined as a rapid back and forth movement of a body part. It reflects a mechanical signal that is termed velocity signal but also kinematic or accelometric signal. The EMG exhibits a broad frequency range, but the rhythmic ‘bursting envelope’ of the EMG observed during slow movements represents tremor frequency.

### The finding of a more or less stable corticomuscular coherence in a frequency range that overlaps with the alpha band is interesting because resonance frequency of different body parts varies to a very large degree. Resonance frequency is the frequency at which – due to biomechanical factors – body parts have a preferred tendency to move. As an example, for the unloaded finger, resonance frequency is around 25–27 Hz. For the longer body parts, such as the wrist, elbow, arm, and leg the respective frequencies are at around, 9, 2, 0.98, and 0.85 Hz respectively.The movement of two legs during walking is the most prominent example of body part oscillations. It can be described in terms of coupled oscillators . Each leg ‘swings’ in a similar way as a pendulum does and its preferred frequency is close to its resonance frequency of about 0.85 Hz. The resonant frequencies of arms and legs are similar, allowing them to oscillate at the same frequency. It is an interesting observation that at self selected (but also faster) walking speeds (of about 1.5 m/s and beyond) arms and legs oscillate at the same frequency and in phase within each body side, but in counterphase relative to the opposite body side. Ipsilateral limbs swing in phase but are in counterphase to their contralateral limbs . The movement of arms and legs can be described as two pairs of coupled oscillators, operating in synchrony with a 1 : 1 frequency ratio.

### Coupled oscillators desynchronize for sufficiently small couplings and then bifurcate to partially synchronized states when the coupling increases above a critical value . Cross-frequency coupling (CFC), which is the interaction between oscillations in diferent frequency bands, is a widely observed phenomenon in the brain that may play a functional role in neuronal computation, communication, and learning. There are various types of CFC, including phase-phase, phase-frequency, phaseamplitude, amplitude-amplitude, frequency-frequency, and amplitude-frequency. In particular, phase-amplitude coupling changes quickly in response to sensory, motor, and cognitive events and correlates with performance in learning tasks . The coupling between glial and neuronal oscillators may be more complex, since the coupling is not compatible with any known type of CFC. Therefore, this interaction may be revealed only through nonlinear analyses, such as crossrecurrence plot analysis. Bipedal locomotion is another example of binary coupled oscillators. Leg movement during walking can be described in terms of two oscilaltors that oscillate in counterphase. When full body weight is on one leg (e.g. red circle at the peak of the red sinüs wave), the other leg does not carryb body weight. ( in the green sinus wave) Red and green sinüs waves describe stride frequency (f) which is defined by the leg angle time series . Step frequency is characterized by the black sinus wave. Stride frequency for slow to medium walking speed is around 0.9 Hz.

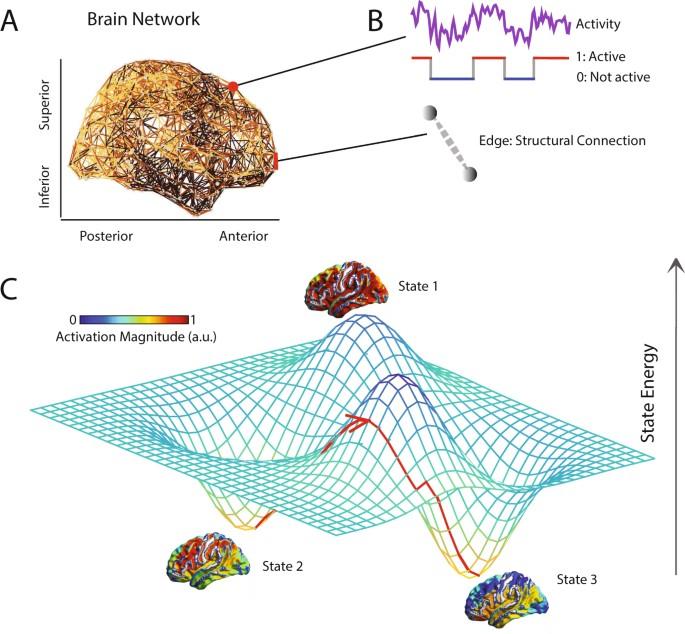
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### Figure 7

### Fig.69. The binary hierarchy brain body oscillation theory provides an algorithm that describes the relationship between brain and prominent body oscillations such as HR, BF, and LFF quite faithfully. Two distinct body oscillations, traditional Mayer waves with a frequency of about 0.1 Hz, and gastric waves with a frequency of about 0.05 Hz fall outside the frequency bands that are predicted by the binary hierarchy. They are not frequency aligned to the oscillations that establish the binary hierarchy.

### Continuous interactions between physiological body–brain rhythms influence how individuals act, perceive, and evaluate their environment. Although the most evident body rhythms such as respiration and heart rate (HR) are considerably slower (roughly 0.25 Hz and 1.25 Hz, respectively) than the most frequently studied neural rhythms (1–50 Hz;) and quite variable across the lifespan, empirical evidence confirms their tight link to neural and cognitive functions. Body rhythms might directly influence neural spiking and oscillatory activity and modulate information processing, perception, action, cognition, and emotion regulation. The combined assessment of rhythmic body–brain signals is critical to advance a holistic understanding of how individuals solve the fundamental task of continuously evaluating, reacting, and adapting to a dynamically changing environment. The central tenet of the body–brain dynamic system (BBDS) is to regard the body and the brain as independent subsystems that dynamically transition from decoupled to coupled states in a context-specific manner. In contrast to static hierarchical conceptions, the body–brain coupling instantiates a transient state that is interchangeably driven by either the body or the brain according to environmental contingencies.Neurophysiological activity is characterized by periodic fluctuations in the excitability of neuronal populations. Rhythmic oscillatory activity is clustered (with some flexibility in the bandwidths) in multiple frequency bands, ranging from delta (1–4 Hz), theta (4–8 Hz), alpha (8–12 Hz), beta (12–25 Hz) and gamma (from 25 Hz onwards). These oscillations and their relation to cognitive function have been extensively studied in the domains of attention, sensorimotor behavior, speech, and music, while aberrant neural oscillatory activity is linked to dysfunction thereof.

Philosophically, the supposed separability and additivity of brain states suggests the presence of strong constraints on the patterns of activations that can be elicited by the human’s environment. The two most common types of constraints studied in the literature are energetic constraints and structural constraints[https://www.nature.com/articles/s41598-018-20123-8](https://www.nature.com/articles/s41598-018-20123-8#ref-CR10). Energetic constraints refer to fundamental limits on the evolution[https://www.nature.com/articles/s41598-018-20123-8](https://www.nature.com/articles/s41598-018-20123-8#ref-CR11) or usage of neural systems[https://www.nature.com/articles/s41598-018-20123-8](https://www.nature.com/articles/s41598-018-20123-8#ref-CR12), which inform the costs of establishing and maintaining functional connections between anatomically distributed neurons[https://www.nature.com/articles/s41598-018-20123-8](https://www.nature.com/articles/s41598-018-20123-8#ref-CR13). While energetic constraints exist at the level of the ATP required to fire an action potential, they also exist at a larger scale and slower frequency where they are thought to tune large-scale brain states[https://www.nature.com/articles/s41598-018-20123-8](https://www.nature.com/articles/s41598-018-20123-8#ref-CR16) across a landscape of dynamic attractors[https://www.nature.com/articles/s41598-018-20123-8](https://www.nature.com/articles/s41598-018-20123-8#ref-CR20). Constraints at this larger scale can be collectively studied within the broad theory of brain function posited by the free energy principle – a notion drawn from statistical physics and information theory – which states that the brain changes its state to minimize the free energy in neural activity. The posited preference for low energy states motivates an examination of the time within and transitions among local minima of a predicted energy landscape of brain activity.



### Fig.70.Conceptual Schematic. (A) A weighted structural brain network represents the number of white matter streamlines connecting brain regions. (B) While neurophysiological dynamics create rich time series of continuously-valued activity magnitudes, we study a simplified model in which each brain region is a binary object, being either active or inactive. (C) A schematic to provide an intuition regarding the nature of an energy landscape for the more general case of continuously-valued brain states. By using a maximum entropy model to infer the landscape of predicted (binary) activity patterns – vectors indicate the regions that are active and the regions that are not active – as well as the energy of each pattern (or *state*)

Odors have shown the property of increasing memory recall, inducing relaxation, or even enhancing humans’ mental abilities. Aromatherapy is a discipline that has been used for millennia as an alternative medicine in different cultures, resulting in effective treatment of some disorders such as insomnia, anxiety, and depression. In addition to these clinical applications, the effects of fragrances on the human mind and behavior is of great interest for all those applications related to everyday life, such as cosmetics, personal care, nutrition, comfort, and psychophysical well-being. The power of scents has always fascinated scientists, who tried to demonstrate their impact at the human psychophysiological level using the most advanced technologies for biosignal and neuroimaging analyses. Studies conducted in the field of the functional magnetic resonance imaging (fMRI) have found that brain regions primarily involved in emotions, such as the amygdala, hypothalamus, and prefrontal cortex are activated during odor stimulation. Regions allocated for memory and recognition such as the lateral and medial temporal cortex have also been implicated in these processes. Some researchers have also pointed out a lateralization of the olfactory processes, in which the left hemisphere is described as related to emotions, while the right hemisphere is linked to memory.

Reactions to olfactory stimuli are not limited to the central nervous system (CNS), i.e., the brain and spinal cord. The brain’s limbic system, activated during emotional responses, is known to be also involved in homeostatic functions that regulate autonomic nervous system (ANS) activity. A positive correlation is found between arousal and skin conductance amplitude and a negative correlation between pleasantness and heart rate. ANS parameters are also known to be sensitive to the stress response and cognitive load due to their link with the sympathetic nervous system. Physiological characterization of odor stimulation can also be determined by the ability of a stimulus to relieve stress or cognitive load. In real life, we are rarely exposed to single and instantaneous sensory stimuli, whether olfactory, auditory, or visual. On the contrary, in our daily life, we often interact with these stimuli over a prolonged period. Although the perception of this smell varies over time and habituation effects come into play, it is possible that our brains continue to be stimulated by it.

### Evidence suggests that neural rhythms adhere to a specific spatio-temporal organization whereby functional coupling across space, time, and frequency is associated with local cytoarchitectonic structure, specific anatomical connectivity, as well as with cognitive function. For example, the coordination of excitability changes across neuronal populations may render perception an essentially rhythmic function which depends on the phase and rate of the respective oscillations .The perpetual activity of the cerebral cortex is supported by the variety of oscillations the brain generates, spanning a number of frequencies and anatomical locations, as well as behavioral correlates. Most forms of brain rhythms are inhibition-based, producing rhythmic volleys of inhibitory inputs to principal cell populations, providing alternating temporal windows of relatively reduced and enhanced excitability in neuronal networks. These inhibition-based mechanisms offer natural temporal frames to group or “chunk” neuronal activity into cell assemblies and sequences of assemblies, with more complex multi-oscillation interactions creating syntactical rules for the effective exchange of information among cortical networks.

Computation in the cerebral cortex of all mammals has two essential features: local-global communication and persistent activity.Due to the bidirectional and highly branched connectivity of neurons throughout the mammalian brain, the results of local computations are broadcast to widespread areas so that multiple structures are informed simultaneously around any given local activity. The inverse is also true: local circuits are under the continuous control of global brain activity, referred to by terms such as “brain state,” “top-down” or “attentional” control. The fundamental feature of the cerebral cortex is its persistent activity, ie, an ability to ignite and maintain a long-lasting trace after the initial input has already vanished.For example, a transient perturbation, such as hearing someone's name in a particular context, can trigger internally generated brain activity for several minutes. In the case of sleep, which is an extreme example of persistent activity, since activity is maintained free of external inputs, a transient perturbation can have a lasting impact. Both local-global communication and persistent activity require special structural and dynamic organization.

Local-global interactions and persistent activity can be maintained by the interactive systems of brain oscillations. The cerebral cortex is perpetually active as reflected by the ever-changing landscape of the electroencephalogram (EEG). Traditional quantitative investigation of the EEG is performed by calculating the spectral power distribution of long-duration recordings, ie, the relative amplitudes, or “energies” of the various frequencies comprising the EEG or other extracellularly recorded signal. A striking aspect of the extracellular signal is its self-similarity (“fractal” nature) in both space and time, wherein the fundamental features of the extracellular signal recorded by microelectrodes or large scalp electrodes over different cortical structures are the same, even though the recorded volume of neurons differs in orders of magnitude. The brain patterns that characterize the cognitive moments may have some nonoscillatory or irregular components, but are typically largely oscillatory in nature and return reliably to the same states after the information is processed. Even in short time windows several rhythms and nonrhythmic patterns can coexist. The frequencies of the various rhythms have a noninteger relationship with each other and the resulting interference patterns lead to the appearance of “noise.”

Neuronal networks in the mammalian forebrain support several oscillatory bands (families of oscillations) that span from approximately 0.05 Hz to 500 Hz. There are a number of boundary lines drawn to delineate cortical oscillations which have been empirically found to act relatively independently. The frequencies occupied by these bands have relatively constant relationships to each other on a natural logarithmic scale and tend to have constant ratios between any given pair of neighboring frequencies.  Constrained largely by the slow axon conduction velocity of the neurons, when the available time is short, as is the case of higher frequency oscillations, the participating neurons are confined to a small volume of nervous tissue. In contrast, during slow oscillations many neurons in a large volume of tissue can be recruited to the rhythm. Mainly due to this structural constraint, when multiple rhythms are present simultaneously, the phase of the slow rhythm(s) modulates the power of the faster one(s). This “cross-frequency phase coupling,” first demonstrated between theta (0,4 to 9 Hz) and gamma (γ, 30 to 90 Hz) oscillations, is a general mechanism for all known rhythms [https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref16) and it undergirds a hierarchical organization of brain rhythms.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref17)

### Figure 1.

Fig.71. A system of interacting brain oscillations. Oscillatory classes in the cortex. the linear progression of the frequency classes (written next to commonly used name for each rhythm), on the natural log scale. This geometrical order is despite the fact that these frequency families are defined based on phenomenological correlates. Reproduced from ref 7: Buzsaki G, Draguhn A. Neuronal oscillations in cortical networks. *Science.* 2004;304:1926-1929. Copyright © American Association for the Advancement of Science 2004.

### Figure 2.

Fig.72.Oscillations can route information by multiple mechanisms,

(a) View of the brain showing location of computation as revealed by transient γ oscillations (i-iv) and θ oscillation in the hippocampus (HI) entorhinal cortex (EC). Brain rhythms of the same and different kind (eg, θ, γ) can influence each other within and across structures by modulating the phase and/or the amplitude of the oscillations,

(b) Phasephase coupling of “synthetic” γ oscillations between two structures for illustration purposes. Phase is shared between the waves — see dashed gray lines and coherence plot regardless of amplitude. Coherence spectrum between the two rhythms can reveal the strength of phase coupling,

(c) Cross-frequency phase-amplitude coupling. Here the phase relationship between the respective γ oscillations can be random but the envelope of γ waves at both sites is modulated by the common θ rhythm and can be revealed by the power-power correlation (comodugram; *right*),

(d) In addition to phase-amplitude coupling (θ-γ), the two sites may display γ coherence as well; a sign of strong inter-site interaction,

(e) Cross-frequency phase-phase coupling. See also *Figure 4.* (f) A slow rhythm (eg, hippocampal θ oscillation) can modulate γ power at multiple neocortical areas so that the results of the local computations are returned to the hippocampus when the hippocampal network is in “readiness” phase of the slow oscillation.

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### It is critical to emphasize that preservation of cortical rhythms across species does not reflect the brain’s inability to change timing mechanisms, and rhythms can adapt effectively according to the needs of given species. For example, central pattern generators for walking and respiratory rhythms vary according to ecological needs from 0.5/min in large aquatic mammals to 100/min in mice. Instead, the constancy of brain oscillations across species seems to reflect the importance of timing as well as an inheritance of the same coding mechanisms. The preservation of temporal constants that govern brain operations across several orders of magnitude of time scales suggests that the architectural aspects of the brain, such as scaling the ratios of neuron types, modular growth, system size, intersystem connectivity, synaptic path lengths, and axon caliber are subordinated to a temporal organizational priority.Most network oscillations are based on inhibition wherein populations of principal neurons are paced by repetitive trains of inhibitory postsynaptic potentials. These rhythmic inhibitory volleys provide windows of alternating reduced and enhanced excitability of principal cells in a temporally coordinated manner.  Segregation of excitatory principal cells into functional groups, referred to as cell assemblies and assembly sequences,is the most important service performed by the large family of inhibitory neuron classes in the cortex. Inhibition-based oscillations do so by providing a natural means to “stop” signals of neuronal information flow by temporally silencing principal cells and “chunking” streams of messages into shorter frames, as evidenced by the observation that oscillations have well-defined onsets and offsets with characteristic maximum and minimum spiking activity in the information-transmitting principal cells. This stop-start parsing function of neuronal oscillators and their hierarchical cross-frequency coupling organization support syntactical rules, known to both sender and receiver, making communication more straightforward than interpreting long uninterrupted messagesor stochastic patterns of spikes.

### Syntax is a set of principles that allows the generation of rich combinations from a limited number of elements using a minimal number of rules. The fundamental element of neuronal syntax is an assembly of neurons discharging together in a γ cycle. The most important role of the cell assembly is to bring together sufficient numbers of peer neurons so that their collective spiking can bring above discharge threshold the proper population of downstream postsynaptic neurons.F[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref52)rom the point of view of the downstream (“reader” or “integrator”) target cells, collective activity of upstream neurons is classified as a single event[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref53) only if their spikes occur within the time-integrating window (ie, within the membrane time constant of the neurons, tends to be 10 to 30 msec; if signals occur within this time scale, they will be combined as a unitary event).[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref54) Spikes of upstream neurons which fire outside the integration time window must be part of another event, or a separate assembly. The temporal window or the membrane time constant corresponds to the duration of the γ cycle (a 40-1 Iz oscillation yields cycle lengths of 25 ms) closely related to other biophysical properties of neurons, including the time constant of γ-aminobutyric acid (GABA)A and α-amino-3-hydroxy-5-methyl- 4-isoxazolepropionic acid (AMPA) receptors[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref55) and the critical time window of spike-timing-dependent plasticity.Multiple γ cycles, each containing its own cell assembly, can be thought as being “neural letters” that are combined to create “words” and later “sentences.” More precisely: discrete episodes or packets of shortlasting γ oscillations, are grouped by slower oscillations via cross-frequency phase coupling*.* This packeting can be thought to associate the “letters” contained in the series γ cycles to form a neural “word.” An example would be a γ “burst” which may be cross-frequency coupled to 0 presented in a single θ cycle. Slower rhythms in which θ waves nest can bind such words into “neural sentences,” ie, longer messages of information, coordinated across large brain territories. The hierarchical nature of cross-frequency interactions reflect a mechanism of syntactical organization. The LFP γ oscillatory episodes can be exploited as a proxy for assembly organization monitoring physiological and disease-related alterations of neuronal communication.

Brain rhythms can interact with each other by multiple mechanisms, including phase-phase, phase-amplitude and amplitude-amplitude envelope coupling *.* Oscillators of similar frequency within the same or different anatomical structures can entrain each other by a mechanism known as phase coupling. Phase coupling can be measured by coherence or preferably by more advanced methods, which are independent of the amplitude fluctuations and based exclusively on phase. A well-known example of phase-phase coupling is the coherent θ oscillations throughout the hippocampus-entorhinal cortex system. Multiple regions can generate θ oscillations and all layers form θ dipoles that fuse into a global “monolithic” single θ oscillator. This occurs despite the fact that the θ rhythm generators of isolated regions oscillate at different frequencies.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref31) When oscillators of similar frequencies are coupled, the overall frequency is determined by the fastest one. A temporally interaction between oscillators of similar frequency is expressed by the temporal covariation of their power, known as amplitude comodulation or power-power coupling. In this case, phase constancy between the waves may not be present but, instead, the power (amplitude) envelopes of the oscillators are correlated (comodulation of power). This power-power synchrony of two or multiple oscillators in various networks can be coordinated by the joint phase biasing of the power of the faster oscillations by the slower rhythm, known as crossfrequency phase-amplitude (CFPA) coupling or nested oscillations.

Why slow oscillations can impact faster ones in multiple brain areas has to do with the conduction velocities of cortical neurons. Compared with faster oscillators, slower oscillators involve more neurons in a larger volume[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref86) and are associated with larger membrane potential changes because in longer time windows spikes of many more upstream neurons can be integrated. Cross-frequency phase-amplitude coupling was first described between hippocampal θ and γ rhythms, and extended subsequently to across-structure coupling .  Gamma power can also be phasemodulated by α, spindle,delta,[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref100) switching between UP and DOWN states of slow oscillations and ultraslow[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref23) oscillations.The principle of cross-frequency phase-amplitude coupling generalizes to all known frequency bands in the mammalian cortex and has been reported between all co-occurring oscillators in interactive circuits at frequencies from as low as 0.025 Hz to as high as 500 Hz. For example, the occurrence of hippocampal “ripples” (f 40 to 200 Hz) is coupled to dendritic layer sharp waves and phase-modulated by sleep spindles (12 to 16 Hz). The spindle-modulated sharp wave-ripple complex is phasecoupled to neocortical slow oscillations (0.5 to 1.5 Hz); and all these rhythms are modulated by the ultraslow (0.1 Hz) oscillation.The phenomenon of cross-frequency coupling demonstrates the hierarchical organization of multiple brain rhythms in both space and time and implies that time in the brain is represented at multiple correlated scales.  The mechanisms of cross-frequency coupling form the backbone of a neural syntax, which allows for both segmentation and linking of spike trains into cell assemblies (“letters”) and assembly sequences (neural “words”).[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref53)While local field potentials provide reliable information about the group actions of neurons, they do not fully represent the true common currency of interneuronal communication: action potentials, or “spikes” that the cell “fires.” While local field potential oscillations can be taken as a signal regarding the action potential-generating status of a particular population of neurons, it is mainly the action potential output of the neuron that can inform its downstream partners. The combined spike-field experiments illustrate that time in the brain is coded at multiple temporal scales. Temporal compression is at play while the network is not receiving new sensory input, or is “offline.” Neuronal oscillations organize the spiking activity of multiple neurons in a number of manners, which appear to allow for prediction, recall, consolidation, and creative association.

### Oscillations can promote both spike synchrony and asynchrony that are used synonymously. The most synchronized network patterns occur during sleep, anesthesia and various diseases, such as epilepsy and Parkinson's disease.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref167) In contrast to these states, the effectiveness of a representation system is characterized by high variability with minimal interactions among the constituents, improvement of behavioral taskperformance by increased interspike variability and reduced spike correlation among neurons.Neuronal oscillations enhance the coding ability of neurons.There should be a compromise between the information processing capacity of neuronal networks and the need for some level of synchronization of their neurons for efficient communication. Fast communication among pyramidal neurons in the cortex is established by AMPA-type glutamate receptors, which are weak and have high probability of transmission failures.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref173) In order to convey information to peer neurons, pyramidal cells should come together in transient coalitions, or cell assemblies.The goal of the temporal assembly formation is to discharge the downstream neurons. For effective communication there is a requirement for a minimum level of synchrony so that γ cycle-defined cell assemblies represent a useable packet of information, which contain varying specific content.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref53)Cross-frequency coupling between local γ oscillations and the more global slower rhythms is established by phase synchrony. This coupling mechanism does not imply that the slower oscillation magnifies the synchrony in the γ period but γ cycle-embedded cell assemblies are distributed across the phase space of the modulating slow oscillation. Instead of narrowing the time window of synchronization, multiple assemblies are separated in nested γ cycles within the slower, modulating θ cycle. In contrast to the intuitive “oscillations-enhance-synchrony” picture, temporal synchrony among principal neurons is lowest during θ oscillations and highest during slow-wave sleep.

Another counterintuitive observation is that the coefficient of variation (CV) of the interspike intervals of hippocampal principal cells is also largest during θ-associated exploration behaviors and smallest during slow-wave sleep.The potential mechanism underlying such “paradoxical” asynchrony and spike variability-promoting functions of θ oscillation is its ability to temporally coordinate excitatory and inhibitory synaptic inputs to neurons.Modeling studies have demonstrated that temporally precise correlated fluctuations of excitatory and inhibitory currents can reduce or cancel each others' action and decorrelate the synaptic current of postsynaptic neurons. As a result, spike timing variability can increase and synchrony across neurons can be reduced, due the strong θ-correlated excitatory and inhibitory inputs impinging upon most pyramidal cells. Under this hypothesis, precise temporal coordination and synchrony have different meanings, since sequential but temporally precise activity of neurons are deemed asynchronous or “polychromous”[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref177) not synchronous.

### The temporal coordinating properties of network oscillations are not only relevant to the healthy brain, but also with the pathological processes of psychiatric disease. Psychiatric disease includes symptoms of disordered emotion, perception, and reality testing, well-defined personality disorders and other characterological disorders wherein subtle disruptions of socialization, attachment and overall personal functioning are described. Despite the fact that many symptoms in psychiatric disease do not lie in the domains classically studied by electrophysiologically-oriented neuroscientists, such as visual perception, spatial processing, or learning and memory, it has become clear that all psychiatric disorders have a basis in the brain and likely electrophysiologic processes. Indeed neural circuits from invertebrates to vertebrates and from the cortex to the limbic system have been shown to consistently share many fundamental properties, including basic principles of connectivity, oscillatory activity, and oscillation-related control of assembly spike timing.

### Healthy adults show a remarkably stable power spectral pattern in the 8 to 16 Hz band during sleep, which allows >90% correct discrimination among individuals, independent of the level of education or general intelligence. Monozygotic twins show high similarity of spontaneous EEG for all frequencies and brain areas with close to correlations levels of r = 0.9 across pairs. The concordance within heterozygotic twins is less but still higher than between non-twin siblings. Not only self-organized (“spontaneous”) but also reactive patterns are under strong genetic control, as shown by a high index of heritability (0.9) of visually induced y-band (45-85 Hz) activity. The quantitatively reliable discrimination between brains by physiological means lead to the suggestions that they can be used for “fingerprinting” individuals.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref191) Such characterization may be further improved when brain oscillations are not considered separately but as a system and when cross-frequency coupling mechanisms are also taken into consideration. If fingerprinting of individuals is possible by EEG and magneto-encephalogram (MEG), it is certainly a useful way to characterize neurological and mental diseases from the perspective of brain activity. Such “rhythmopathies,” “oseillopathies” or “dysrhythmias” may reflect malfunctioning networks.

The predominant mode of psychiatric treatmentis based on pharmacology and network level phenotypes as an intermediate link between disease and drug action. Brain network-specific oscillations and cross-frequency coupling of their interactions can be quantified effectively in both sleeping and task-solving animals, and since network patterns are specifically and differentially affected by a large spectrum of psychotropic drugs, they can be used in early screening. Unlike the often-varying drug responses between humans and animal models across many measures,the pharmacological profiles of network oscillations are identical in all mammalian species. The oscillation-centric approach offers an alternative to pharmaceutical-based interventions: direct assessment and potential correction of aberrant brain activity based on the measurement of that activity itself. A version of such therapies have existed for years in the form of biofeedback, where patients are presented with various transforms of their brain rhythms and requested to alter brain rhythms in a particular direction using cognitive control. With varying degrees of practice, patients are able to learn to self-alter their brain oscillations as a proxy for improving other symptoms such as anxiety. Cognitive processing exhibits rhythmic fluctuations, linking the oscillatory patterns of neuronal activity to periodic fluctuations in perception, attention , decision-making or memory reactivation . For example, it has been demonstrated that visual perception cycles as a function of the cortical alpha (8-12 Hz) phase and the allocation of attention varies periodically as a function of low frequency oscillations. Novel non-invasive brain stimulation approaches, which allow for the frequency-specific entrainment of neuronal activity, have linked neuronal oscillations to perception and behavior. Eendogenous neuronal oscillations provide the functional architecture of conscious perception and various higher cognitive functions.

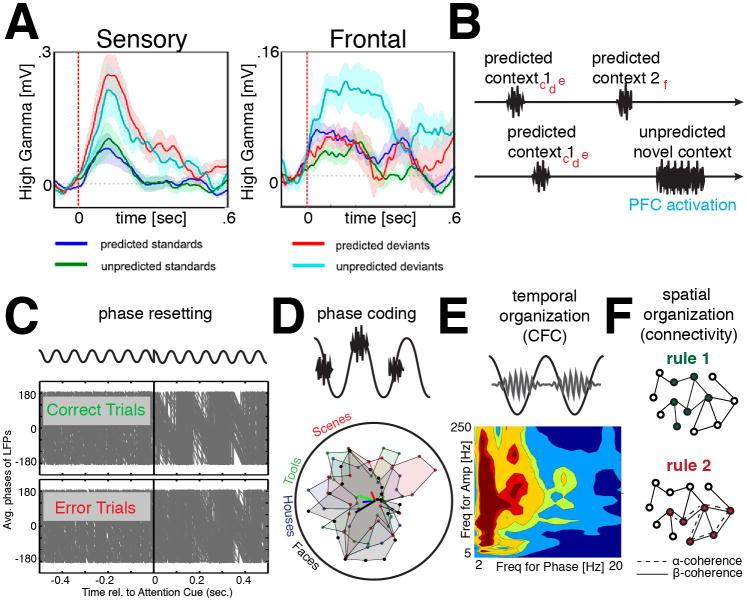


Fig.73.

* 1. High gamma responses to standard and deviants in sensory and frontal regions.
  2. Illustration of two predicted contexts, where a brief burst of activity might be coordinated by the underlying oscillatory dynamics. Different contexts could be embedded in distinct spatiotemporal configurations (red letters indicate examples) of the same network.
  3. The grey lines indicate the low frequency phase of single trials. the increased phase consistency for correct trials (upper panel).
  4. Activity at different time points during the oscillatory cycle encodes distinct categories. Houses (blue), scenes (red), tools (green) and faces (black) were encoded at different phases and frequencies of the underlying low-frequency oscillation.
  5. Cross-frequency coupling could mediate cortical computations and information integration across several temporal scales. The example data shows that the phase of delta/theta activity (2-5 Hz) modulates the amplitude in a broad range of frequencies (10–250 Hz).
  6. Frequency-specific connectivity patterns encode distinct task relevant rules. The schematic depicts how the same neuronal assembly might have been differentially connected to encode two different rules (rule 1: color vs. rule 2: orientation). Furthermore, different frequency bands allow multiplexing different computations on several temporal scales.

Multiple studies have demonstrated that phase resetting of low frequency oscillations by task-relevant cues facilitates subsequent behavior. For example, it has been shown that correct shifts in attention lead to pronounced phase resets in prefrontal and cingulate areas. Phase resetting imposes coherent activity in wide-spread cortical regions aligning spatiotemporal dynamics in task-relevant sites and controls the exact timing of neuronal activity, e.g. that a burst of activity coincides with the next behaviorally relevant event at a certain LFP phase to enable efficient cortical processing and inter-areal communication. Distinct stimulus categories may be encoded at different phase angles of low frequency oscillations. This phase encoding is also associated with an increase in cross-frequency coupling that may subserve the cortical organization across temporal scales particular. Activity at different phases of the ongoing activity may carry distinct behaviorally relevant information. Phase synchronous ensembles form task-relevant networks, which coordinate intra- and inter-areal information flow. The popular communication-through-coherence (CTC) hypothesis suggested that neuronal communication might be established through coherently oscillating neuronal assemblies. The rich spatiotemporal correlation structure of the brain may enable effective cortical computation and information transfer. This is in line with the spectral fingerprint hypothesis, which proposed that different spectral patterns might reflect distinct canonical neuronal computations. Most findings on inter-areal long-range connectivity highlighted a role of synchronized low frequency oscillations (< 30 Hz), while high frequency activity (> 30 Hz) probably reflects broadband shifts due to changes in the neuronal firing rate. Amplitude correlations of high frequency activity may capture interactions between functionally connected, but non-synchronous.

Neuronal communication has classically been conceived of as being determined by structural anatomical connectivity and by activity-dependent changes to the anatomical (ultra)structure of the connection. Even in the absence of changes in (ultra)structural connectivity, neuronal synchronization as an emergent dynamic of active neuronal groups has causal consequences for neuronal communication. If neuronal communication depends on neuronal synchronization, then dynamic changes in synchronization can flexibly alter the pattern of communication. Such flexible changes in the brain's communication structure, on the backbone of the more rigid anatomical structure, are at the heart of cognition.Neurons are the basic working units of the nervous system that process information by propagating electrochemical signals through action potentials. Neurons are not electrically neutral nor extracellular fluid because of the presence of ions within them. Ions are constantly moving in and out of the cell through a membrane that can dynamically modify its electric permeability with external electrochemical signals. The flux of ions entering and exiting the cell causes a virtual current flow through the membrane, mostly ascribed to Na+, K+, and Cl− ions.When encoding an image, each individual pixel value ranging from 0 to 255 can be simply used to produce the spike time that is proportional to the brightness of the pixel. For instance, a pixel with normalized brightness of 0.1 corresponds to a spike time at 𝑡=0.1. In a grayscale image, white pixels (brightness equals 1 or 255) do not cause spikes, as it can be considered that they do not carry any information.Biology shows that the event-based paradigm is applicable not just to perception and inference but also to control. Spiking neural networks (SNN) have been utilized as a “brain” of robots that provides robotic perception and action to mimic the behaviors captured in nature. Many fields of robotics, e.g., locomotor systems, have been inspired by biological systems. Locomotion in a variety of robots, has been achieved through a central pattern generator (CPG) , a neural network in which interconnected excitatory and inhibitory neurons produce an oscillatory, rhythmic output without some rhythmic inputs.

TTFS coding in a feed-forward network is a high-level abstraction of some key aspects of signal transmission in the brain. In the cortex, transient spiking activity initiated by short visual stimuli travels in a wave-like fashion along the visual processing pathway, with significant delays between visual areas, but short response duration in each area A large fraction of information about image identity is contained in the first 50 ms after response onset in early[https://www.nature.com/articles/s41467-024-51110-5](https://www.nature.com/articles/s41467-024-51110-5#ref-CR71) as well as higher areas. In a time window of 50 ms most neurons emit at most one or two spikes, and only a few neurons more than five spikes. Different neural circuits in the brain are involved in the development of different cognitive functions and teh adaptive synergy of the circuits promotes human perception, learning and decision making. In biological neural systems, neurons are the most basic computing units, and different types of neurons are capable of self-organizing to form different neural circuits for achieving a variety of cogniitve functions to play different roles. Neurons do not function in isolation, and during the long-term evolution of the human brain, neurons are connected to form specific circuits. Different circuits produce different cognitive functions. The feedforward and feedback inhibition circuits are used to regulate excitatory signals within cortical microcircuits. The recurrent excitation helps to amplify the feedforward signals. The human brain realizes various cognitive functions such as perception, reasoning, and decision-making through dynamic combinations of different neurons, circuits, and brain areas. Binary spikes is a key factor for the energy efficiency of biological brains. Spiking Neural Networks (SNNs) have been developed which comprise of *spiking neurons*. Information transfer in these neurons mimics the information transfer in biological neurons, i.e., via the precise timing of spikes or a sequence of spikes. Similar to the brain, neurons in spiking neural networks (SNNs) communicate via short pulses called spikes that arrive in continuous time—in striking contrast to artificial neural networks (ANNs) where neurons communicate by the exchange of real-valued signals in discrete time.

ANNs are the basis of modern artificial intelligence with impressive achievements. Information transfer in these neurons mimics the information transfer in biological neurons, i.e., via the precise timing of spikes or a sequence of spikes. Spiking Neural Networks (SNNs) are considered the third generation of Artificial Neural Networks (ANNs). They communicate using asynchronous spikes, similar to how the brain processes information. Unlike real-value-based ANNs, spiking neurons have rich spatiotemporal dynamics by receiving presynaptic information (spatial), accumulating membrane potential over time (temporal), and releasing spikes when the threshold is exceeded. SNNs outperform shallow ANNs in adversarial attack, noise robustness, continuous learning, and simulation of brain cognitive functions. The structure of the current high-performance SNNs uses the same network structure as the advanced nonspiking ANNs, such as the residual structure, inception structure, and transformer structure, replacing only the nonlinear activation functions with spiking neurons. Artificial Neural Network (ANN) models are based on highly simplified brain dynamics. They have been used as powerful computational tools to solve complex pattern recognition, function estimation, and classification problems. Spiking is enabled by temporally focusing shunting to certain time periods, while leaving others devoid of it. This time-sharing is achieved by the gamma rhythm, which focuses perisomatic inhibition in one part of the gamma cycle, and thereby leaves another part free for neurons to respond to excitatory input. This excitatory phase of the gamma cycle sees decaying inhibition and a temporally focused rise in excitation. Such synchronized excitation generates rapid postsynaptic depolarization, ideal to trigger spikes .

Gamma-band coherence renders communication not only effective but also precise. The gamma rhythm times the inhibition in the postsynaptic group to vanish just before another round of synaptic inputs arrives, and it focuses those synaptic inputs to arrive simultaneously. This synchronous arrival of synaptic inputs is an important component of a precise communication protocol, that conveys a neuronal representation in the spatial pattern of spike rates in the presynaptic neuronal group. This presynaptic spike rate pattern translates into a spatial activation pattern among the synaptic inputs to the postsynaptic group. The synaptic input pattern, multiplied by the pattern of synaptic strengths, determines the level of postsynaptic depolarization and subsequent spike rate. The spike response is a precise function of the neuronal representation conveyed by the active set of synaptic inputs. Synaptic currents (at least the dominant AMPA- and GABAA-receptor mediated currents) decay within a few milliseconds. If synaptic inputs are jittered, even by merely a few milliseconds, this would substantially compromise the precision of the postsynaptic response, i.e. the degree to which it is determined by the presynaptic spatial spike rate pattern. By decreasing such jitter, CTC mechanisms increase postsynaptic response precision. CTC renders inter-neuronal communication pulsatile, because communication happens only during a relatively small fraction of the synchronization cycle. Pulsatile communication results in pulsatile computation and a pulsatile postsynaptic neuronal representation. In visual cortex, neurons spike earlier in the gamma cycle when they are driven by stimuli closer to their preferred stimulus in the cortical stimulus selectivity map, a given stimulus results in a systematic gamma wave of spiking, sweeping from the more to the less strongly activated columns. Postsynaptically, the synaptic inputs from more strongly activated neurons will arrive earlier and will thereby have a larger influence before inhibition curtails further effects.

In addition to rendering communication effective and precise, coherence also renders communication selective. If one set of synaptic inputs, constituting one neuronal representation, succeeds in triggering postsynaptic excitation followed by inhibition, this inhibition closes the door in front of other inputs. Those other inputs are then unable to transmit the neuronal representation that they constitute, and they are unable to trigger inhibition themselves. Thereby, the winning set of synaptic inputs conquers the perisomatic inhibition in the postsynaptic neuronal group, entrains it to its own rhythm, and thereby establishes a communication link that is selective or exclusive. This selective communication link is an ideal candidate mechanism for implementing selective attention, concretely the selective routing of attended sensory representations. When e.g. one out of several visual stimuli is attended, because it is behaviorally relevant, the early visual cortical representation of this attended stimulus is preferentially communicated to postsynaptic neuronal groups, at the expense of other, unattended, stimuli .

From lower to higher areas of visual cortex, neuronal projections converge such that postsynaptic neurons respond selectively to particular conjunctions of simpler stimulus features; At the same time, this convergence renders responses invariant, i.e. insensitive to stimulus dimensions like the precise stimulus position, which are already represented with high precision in early visual areas . This increasing spatial invariance with increasing hierarchical level is reflected in increasing receptive field (RF) sizes. Invariance appears necessary, because it readily offers a neuronal mechanism of stimulus recognition unperturbed by stimulus deviations in irrelevant details. Also, it avoids a combinatorial explosion that would result, if object-selective higher-area neurons represented particular sensory realizations of particular object tokens. The convergence that produces both stimulus selectivity and invariance unavoidably results in a situation, in which a given postsynaptic neuron often receives synaptic inputs containing the representations of more than one perceptual object. When a single neuron in a higher visual area responds with different firing rates to different stimuli, the simultaneous presentation of both stimuli in the neuron's RF results in a firing rate that is a weighted average of the response to the isolated stimuli . This is the case when attention is directed away from both stimuli. When attention is directed towards one of the two stimuli, the firing rate of the postsynaptic neuron represents primarily the attended stimulus. In the same attention tasks, presynaptic neurons in lower visual areas, whose smaller RFs contain only one of the two stimuli, show only small effects of attention on their firing rates. Thus, with two visual stimuli, there are two sets of presynaptic neurons in lower visual areas, with firing rates hardly affected by attention, and postsynaptic neurons in higher visual areas, with firing rates dominated by the attended stimulus.

Both the frequency and the strength of gamma-band synchronization lends the lower-area neuronal group that is activated by the attended stimulus, a competitive advantage in entraining postsynaptic neurons in higher areas. The selective entrainment of the higher area to the part of the lower area representing the attended stimulus constitutes the implementation of attentional selection. It is important to make the distinction between the implementation of attentional selection and the control of attentional selection. While the control of attentional selection is exerted by frontal and parietal areas through top-down influences onto visual areas, the implementation of attentional selection is realized by selective bottom-up influences of lower onto higher visual areas. The implementation is through selective inter-areal gamma-band synchronization, which is predominantly bottom-up, the control is expected to be through top-down influences of fronto-parietal areas onto visual areas and/or higher visual areas onto lower visual areas. Top-down influences are mediated by alpha-beta-band rhythms The theta rhythm constitutes a visual exploration routine. When the behavioral context allows the eyes to explore the visual environment freely, they saccade at a theta rhythm. If the context requires the eyes to fixate for prolonged durations, the cortical theta phase modulates the strength of gamma-band synchronization, which is identified as implementation of attentional selection. Irrespective of saccades as overt expressions of attention, selective attention samples visual input at a theta rhythm.

The hypothesis of communication through coherence(CTC) proposes that coherent or synchronous oscillations in connected neural systems can promote communication and selective communication among neural networks is achieved by coherence between firing rate oscillation in a sending region and gain modulation in a receiving region.  It has been applied mainly to how oscillations interact in connected networks to respond selectively to a task-relevant ‘target’ signal while ignoring other distracting inputs. Free viewing of natural images induces gamam band odcilaltions in early visual cortex.If the gamma rhythm in a lower visual area entrains a gamma rhythm in a higher visual area, this woulsd establish an effective communication protocol: the lower area sends a representation of the visual stimulus rhythmically and the higher area is most excitable precisely when this representation arrives. At other times , the higher area is inhibited , which excludes competing stimuli . This scenario is referred as communication through coherence(CTC) hypothesis that proposes that anatomical connections are dynamically rendered effective or ineffective through the presence or [absence](https://www.sciencedirect.com/topics/neuroscience/epileptic-absence) of rhythmic synchronization, in particular in the gamma and beta bands and uni-directional communication is due to rhythmic entrainment with an inter-areal delay and a resulting non-zero phase relation, whereas bi-directional communication is due to zero-phase synchronization. Studies found that inter-areal gamma-band synchronization entails a non-zero phase lag. For unidirectional communication, an oscillation in a sending group may entrain an oscillation that is intrinsically generated in the receiving group or even simply drive an oscillation in the receiving group. In this case, the conduction delay would, for a given frequency, directly translate into a relative [non-zero] phase . For bi-directional inter-areal communication, the original CTC statement assumed that neurons participating in a communication link are synchronized at zero phase both within and between areas.

Anatomical tracing studies suggest that neurons of a given area that receive input and those that send output are almost completely separate. While one set of neurons entrain to incoming rhythmic input, a different set may provide rhythmic output. Those separate, neighboring, sets of neurons locally communicate via rate-based mechanisms and/or be synchronized in a non-rhythmic way. Alternatively, receiving and sending neurons within a given area have a particular non-zero phase relation to each other, which should be visible if the separate sets of neurons are not intermingled, but segregated e.g. in layers. Bi-directional cortical communication is realized by CTC acting separately in the two directions, with both inter-areal and inter-laminar delays. While anatomical connectivity shapes neuronal communication, it does not fully determine it, because cognitive variables can act as powerful gates to open or close communication links. Anatomy presents a backbone that can give rise to a diversity of functional interactions. Dynamic changes in functional interactions are at the heart of our cognitive dynamics, which subserves adaptive [behavior](https://www.sciencedirect.com/topics/neuroscience/behavior-neuroscience). A hallmark characteristic of neuronal activity is rhythmic oscillation in several distinct frequency bands ranging from ultraslow to ultrafast, from approximately 0.05Hz to 500Hz, as shown by local single cell spiking activity, local field potentials, EEG, MEG, and, for the very low frequencies, fMRI. Interactions among neuronal groups depending on neuronal (zero or non-zero phase) synchronization modulates the communication and information processing between neuron groups . Two groups of neurons communicate – or exchange information - most effectively when their excitability fluctuations are coordinated in time, i.e. when they are coherent.

Communication Through Coherence (CTC) hypothesis, posits that cortical coherence is a mechanism that can influence the transmission of information between neuronal populations , specifically through gamma - and beta-band (30-90 Hz) synchronization and neuronal interactions depend on phase relations between neuronal oscillations. Central to this hypothesis is the idea that synchronization between neuronal groups can have causal consequences for neuronal communication. Thus, oscillations are proposed to dynamically shape the computational role of different neuronal groups linked through static structural connectivity. More specifically, the CTC principle is an example of an important, well-documented mechanism for the state dependent coupling fundamental for implementing flexible means of effective communication between different brain regions without changing the fixed underlying anatomical structure. Phase relations that time inputs to reach their target at high-excitability, allow an effective transmission of spikes. Consistent phase relations require the synchronization between neuronal groups. Synchronization does not necessarily have to occur at zero-phase difference, and the optimal phase relation depends on the frequency of the involved rhythms and the conduction delays between the neuronal groups. In the absence of synchronization, i.e. in the absence of a consistent phase relation (zero or non-zero), transmission will be relatively ineffective. As a consequence, the state of synchronization between different groups of neurons in different brain areas allows a flexible switch for different routes of effective communication, while maintaining the same underlying skeleton of synaptic/anatomical structural connections.For CTC mechanisms to support communication, synchronization needs to be spatially structured and temporally dynamic to link local neuronal groups into functional networks at the appropriate moments.

Rhythmic synchronization in frequency bands such as theta (4-8 Hz), beta (13-30 Hz), or gamma (30-100 Hz) is related to alternating periods of network inhibition and excitation. The CTC hypothesis suggests that gamma- and betarhythmic changes in excitability have important consequences for neuronal communication. Specifically, the hypothesis states that two groups of neurons exchange information most effectively when their excitability fluctuations are coherent. Conversely, if a synaptic input arrives during the inhibitory phase of the oscillation cycle, its efficacy is reduced (because of shunting inhibition on the neurons receiving the input). Thus the efficacy of spikes in transmitting information may be influenced by synchronization . Consistent with this hypothesis, task-induced changes in synchronization or coherence have been reported at the level of individual regions during selective attention, working memory, and motor control. Such task induced changes in synchronization have been reported between distant cortical regions during working memory, long-term memory encoding, visual attention and sensorimotor integration. Neuroimaging data show that during cognition, large-scale network dynamics exhibit complex spatiotemporal patterns. At very slow frequencies– typically less than 0.1 Hz – correlated activity can be seen and defines robust spatial ‘networks’– even at resting, spontaneous, conditions. At higher frequency, patterns of oscillatory activity can change quickly, and patterns of oscillatory coherence can be seen in multiple frequency bands during task execution. As many cognitive processes involve distributed activity across the brain, understanding the dynamics at the whole-brain scale provide key insights into the nature of cognition. Simply positing a circular causality between functional and effective connectivity does not speak to a specific link between metastability and CTC mechanisms. There are many mechanisms that induce state-dependent coupling in the brain; for example neuromodulatory and mean field effects. For example, it is well known that increases in mean activity levels increases effective connectivity.

The particular form of state-dependent coupling assumed by the original CTC hypothesis depends upon precise phase relationships at gamma/beta frequencies. This is interesting because coupled phase oscillator models of neuronal dynamics can be cast explicitly in terms of the phase entrainment and effective connectivity among the phases of an oscillation. Technically, this dependency is encoded in something called a phase interaction function. The maintenance of a particular communication channel through coherence suggests that a number or repertoire of such coupling dynamics corresponds to the number or variability of persistenphase relationships. This is important because the variability of the Kuramoto order parameter (that reflects the phase relationships) can then be used to quantify the number of realised CTC-like channels. Conscious experiences and behavior arise from synchronous activity in widespread (sub-) cortical regions and a variety of measures have been introduced to assess inter-regional neuronal communication. The CTC hypothesis suggested that areas that exchange information transiently synchronize their activity in distinct narrow frequency bands. The information flow through the cortical hierarchy requires that the information flow is directional along defined anatomical pathways. Latency analyses of evoked activity constitute the most commonly accessible approach to trace the flow of neuronal activity through different cortical regions. Although linear analysis techniques provide valuable insights into brain-behavior relationships, non-linear approaches assessing the phase of oscillatory brain activity such as circular statistics have been used to reveal periodicities in sensory or cognitive functions[https://pmc.ncbi.nlm.nih.gov/articles/PMC5127407/](https://pmc.ncbi.nlm.nih.gov/articles/PMC5127407/#FN2) and address the CTC hypothesis that postulates an important role of the oscillatory phase for inter-areal communication. CFC analyses , that demonstrate a systematic relationship between the phase of slower oscillations and the amplitude of high frequency activity play an important role for the spatiotemporal organization of large-scale networks. Multiple findings suggested that different spectral signatures do not occur in isolation, but are functionally coupled through CFC that constitutes a key mechanism to coordinate the spatiotemporal organization of neuronal networks. Therefore, regions that exhibit local CFC, engage in inter-regional connectivity and captures the non-linear cortical dynamics, which may track behavior better than linear measures . An intracranial attention study in humans showed that delta-gamma CFC in frontal and parietal areas predicted reaction times on a trial-by-trial basis.

At the global level, the brain can be described by a large-scale network of local neural networks –or nodes, linked by long-range connections. The global dynamics of the whole-brain network is determined by the intrinsic dynamics of the nodes, i.e. the dynamics of a node in absence of all couplings, and the network couplings, which allow the communication between the nodes of the network. The local spontaneous dynamics of a single node can be modelled as attractors of a network of spiking neurons coupled through AMPA, NMDA and GABA receptor synaptic dynamics and can be captured by neural mass models. The emergent collective macroscopic behaviour of brain models has been shown to be only weakly dependent on the details of individual neuron behaviour. There are two types of reduced models, those that have used a dynamic mean field model derived from a proper reduction of a detailed spiking neuron model, which itself is asynchronous by definition and those including a-priori oscillatory units . It is possible to combine both, asynchronous and oscillatory scenarios for obtaining a more realistic description of the characteristic of the measured signals. The structure of the physical couplings is specified by the underlying anatomical skeleton, so-called structural connectivity (SC) matrix. In humans, this type of anatomical information, i.e. the SC matrix, can be estimated from Diffusion Tensor Imaging (DTI), where white matter fibers connecting distant neural populations can be modeled via tractography algorithms. (398-444)

On the other hand, the global characterization of the whole-brain dynamics is described by the functional connectivity matrix (FC) which expresses the statistical dependence between brain regions of neurophysiological signals as recorded with indirect measures such as functional MRI and PET, or with direct measures of neuronal activity such as MEG and EEG. The dynamical entrainment and correlations between different local brain region dynamics are crucially shaped by the underlying anatomical structural connectivity. Whole-brain models explicitly link the underlying anatomical SC matrix, shaping the interplay between the local dynamics of each node, with the FC matrix, characterizing the global dynamics of the brain to be used to model important features of sleep, for example. Whole-brain models can provide a mechanistic explanation of the origin of resting state dynamics (i.e. no stimulation, no task). Computational whole-brain models describe the resting activity of each brain region based on a local model, inter-regional functional interactions and a structural connectome that specifies the strenght of inter-regional connections. A significant development in neuroscience involves the conceptualization of the brain as a set of dynamic networks that interact and facilitate information processing through the integration and segregation of information. Correspondingly, the application of formal methods from the graph theory and the statistical mechanics for studying the structure and dynamics of those networks has been essential to this development. The spatiotemporal activity of the brain's resting-state physiology is identified by measuring the inter-regional correlation of the BOLD signal,<javascript:;> so-called resting-state functional connectivity (FC). This spatiotemporal activity arises and is constrained by a structural connectome,a small-world organization,<javascript:;> in which the ‘wiring efficiency’ is maximized by groups of densely interacting sets of brain regions (i.e. networks) that are linked by sparser connections.

The structural organization of the brain generates spatiotemporal dynamics of activity or recurring waves across cortical, subcortical, and cerebellar circuits,which occur within a critical regime. Whole-brain models have simulated activity changes produced by behavioural states, drugs or neurostimulation in the healthy or pathological brain. A key health-related application of whole-brain models is the simulation of the effects of brain pathologies, such as stroke, epilepsy or schizophrenia, on the brain activity and behaviour.Pathology-specific whole-brain models are very important because accurate simulations of the physiological effects of a pathology and their distributed impact on brain networks not only provide insights into disease mechanisms, but allow the effect of therapeutic interventions, such as drugs, rehabilitation or stimulation, to be modelled or predicted.<javascript:;> Functional connectivity in patients could be predicted by a whole-brain computational model strictly from the structural disconnection caused by a patient's lesion, suggesting that the model mechanistically captured to some degree the relationship between anatomical structure and functional activity.

Living organisms depart from thermodynamic equilibrium by consuming energy and dissipating heat to maintain cellular order and perform essential biological functions, such as locomotion and replication. At microscopic scales, these processes define an arrow of time corresponding to the net increase in the entropy of the environment.<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3> This time irreversibility can disappear at larger coarse-grained scales (and the system can appear to be in equilibrium) even while relying on non-equilibrium processes occurring at the molecular scale. The brain, as a living system, exhibits non-equilibrium dynamics at different spatial scales. At the microscale, metabolic and enzymatic activity supports various non-equilibrium processes such as neuronal firing and cellular housekeeping.<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3> The brain must exhibit non-equilibrium dynamics at larger macroscopic scales. Models of non-equilibrium brain dynamics highlighted the scale-free critical behavior of the brain as a key characteristic. By quantifying the entropy production in macroscopic neural data, it has been demonstrated that the brain nearly obeys detailed balance when at rest, but strongly breaks detailed balance when performing physically and cognitively demanding tasks  and shows more temporal reversibility in states of reduced consciousness.<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3>  Different methods have been proposed to quantify the degree of non-equilibrium based on the principle that systems breaking detail balance exhibit temporal asymmetry, known as the arrow of time. Even if the dynamics of a physical system at the microscale is governed by low-order interactions, the emergent behavior may exhibit effective dynamics with high-order dependences.<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3>

At the microscopic scale, it was demonstrated that neurons break detailed balance driven by pairwise interactions. The time irreversibility of a system can disappear (and the system can appear to be in equilibrium) at larger coarse-grained scales even while relying on non-equilibrium processes occurring at the microscopic level.<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3>  The leading non-equilibrium interactions at the macroscopic level being still pairwise reflects a general organizational principle by which the dominance of pairwise interactions driving non-equilibrium dynamics holds across scales, regardless of whether the interacting elements are single neurons or macroscopic brain regions. This scale invariance may be attributed to the critical behavior of the brain, which causes self-similarity—the effect whereby its statistics are re-scaled after undergoing successive coarse-graining at different scales. There are a variety of examples in which complex collective behaviors of a system can be explained using only pairwise correlations, such as bird flocking<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3>  and collective human activity.<https://www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(25)00063-3>

The human brain, composed of billions of neurons and synaptic connections, is an intricate complex neural network, that self organizes into different emergent states crucial for its functions including spatiotemporal patterns of neural synchronization associated with cognitive processes coordinating a sophisticated dynamical balance of excitatory and inhibitory activities between brain regions for adjusting neural input/output relationships in cortical networks and regulating the dynamic range of their responses to stimuli. Brain regions can be modeled as dynamically interacting nodes in a functional network on a 3D space (functional brain networks) , which is coupled in a complex manner driven by the structure of these networks. Inter disciplinary approaches using concepts from non-linear dyanmics, physics, biology and medicine allowed to understand in depht how the human brain functions and certain brain disorders and their underlying mechanisms with further mathematical models. More predictive performance of such models using a vast amount of neuroimaging data e.g. electroencephalography (EEG), magnetoencephalography (MEG), and functional magnetic resonance blood oxygen level dependent (BOLD), functional magnetic resonance imaging ( fMRI) provide information not only for healthy or pathological activity but can also be used to fingerprint functional connectomes by identifying individuals using brain connectivity patterns. Whole-brain modeling is a subfield of computational neuroscience that focuses on simulations of large-scale neural activity across the entire brain. Successful behavior relies on the brain’s ability to flexibly adapt to environmental changes by learning new sensorimotor mappings. (445-448)

Results from single unit studies indicate that neuronal populations in the prefrontal cortex(PFC) exhibit a mixed selectivity i.e. these populations are able to engage in different tasks facilitating cognitive flexibility. Temporal multiplexing constitute a key mechanism of prefrontal integrative functions. Multiplexing refers to a process where different computations are carried out in distinct frequency-bands, that can successfully be separated on different temporal channels. Multiplexing has also been observed in the visual system of both humans and monkeys. Theta and gamma oscillations mediate feed-forward influences (from lower to higher visual areas), while alpha and low-beta oscillations provide top-down feedback. While structural connectivity is mainly assessed by diffusion imaging, functional connectivity can be inferred by circular or linear correlation analyses of band-limited electrophysiological signals. Decreased alpha-and increased gamma-synchronization contralateral to the attended hemi field have been suggested to constitute a hallmark of visuospatial attention. Synchronized oscillatory brain activity is mediated by cortico-cortical connections between specialized regions to facilitate cortical information transfer and integration within narrow frequency-bands . The synchronization of neuronal oscillations across several spatiotemporal scales constitutes a hallmark of the physiologic brain function .Numerous neuropsychiatric diseases have been associated with pathological changes of oscillatory processes. In particular, the symptoms of Parkinson's disease (PD) might be caused by abnormal oscillatory activity. For example, Parkinson rigidity has been linked to elevated CFC between the basal ganglia and motor cortex. Similar oscillatory alterations have been proposed to underlie schizophrenia, autism or attention deficit hyperactivity disorder. Oscillations guide cortical spiking activity and play a causal role for conscious perception and cognitive processing . Cognition emerges from coordinated neuronal activity in specialized widely distributed cortical regions

Neuronal oscillations support flexible cognitive processing by recruiting mixed-selective neuronal assemblies into frequency-specific circuits, which bias distant cortical sites through directed endogenous entrainment. Temporal multiplexing might be ideally suited to subserve cognitive flexibility. In particular, the role of slow oscillatory activity for sensory selection, information integration and goal-directed behavior, determines the timescale and capacity of cognitive processing. Accumulating evidence supports the notion that endogenous oscillatory activity in large-scale networks has a causal function for goal-directed behavior and constitutes a promising direction for future research to unravel to core mechanisms of goal-directed behavior.Neural oscillations play an important role in basic sensorimotor processes related to the execution and preparation of movements. Motor gamma oscillations have been observed for simple movements, including finger movements, tongue protrusions, eye-winking, fist –clenching and foot movements but they hâce been also observed for more elaborated representations of actions such as motor imagerey, mirroring of movements, walking and cycling movements and interpersonal interaction. It has been reported that gamma oscilaltions associated with motor processing are very variable in frequency for very young children, with frequency ranges varying between 35-45 and 70-80 Hz. This variability settle s in 70-80 Hz in children, adolescents and adults. Brain oscillations at the lower end of the spectrum tend to engage large areas, while those oscillations at higher frequencies are localized in restricted cortical areas. Motor gamma activity is associated with the processing of sensory reafferences (from the muscles) in sensory and motor cortical centers. Motor gamma oscillations bind sensorimotor information and facilitate movement. There is evidence that gamma oscillations are associated with the coding of motor parameters like force and direction.

Cognitive control describes the ability to generate, maintain and adjust strategies directed to specific goals, which altogether allows the emergence of flexible behavior. Beyond local activity, gamma oscillations carry information in structures far away apart. Cognitive functions emerge from the cooperative participation of groups of brain regions or networks. While local neural activity covers an area of ∼1 cm through monosynaptic connections, large-scale activity is said to occur between neural assemblies that are over 1 cm apart and involve polysynaptic pathways. Brain–brain coupling can also occur across different frequency bands. Activities in the lower frequency band modulate the amplitude, frequency, or phase of the higher frequency signal. Neural oscillations correspond to rhythmic fluctuations in the excitability of populations of neurons occurring at distinct spatial and temporal scales. The mechanisms that give rise to oscillations involve the interactions between inhibitory interneurons, based on aminobutyric acid (GABA)ergic neurotransmission, and excitatory pyramidal cells, based on glutamatergic neurotransmission. Besides neurotransmission, gamma oscillations also emerge as a result of network properties, such as mutual inhibition, mutual excitation and recurrent inhibition. Unbalanced neurotransmission and alterations of oscillatory activity have been associated with neuropsychiatric and neurological disorders. (449-450)

To control extreme or difficult symptoms, aberrant brain activity can be restored by appropriately patterned electrical stimulation. In many diseases, symptoms recur irregularly and unpredictably and are often separated by long symptomless intervals.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3553572/#ref225) In such instances, closed-loop feedback brain control that leaves other aspects of brain functions unaffected is desirable. Effective clinical application of closed-loop treatment has two fundamental requirements. The first is recording and identifying causal pathophysiological network patterns. The second requirement is closed-loop feedback stimulation of the target circuits whose activation can interfere with the emerging pathological pattern.  The spike components of the pattern can be readily detected by surface or scalp recordings and used as a trigger to trigger an effector mechanism. Using transcranial electrical stimulation (TES) or optogenetic activation of the neocortex as effectors, closed-loop feedback can effectively reduce the duration of seizure episodes. Noninvasive, closed-loop stimulation may prove effective affecting identifiable brain states. For example, “synthetic” sleep spindles can be induced by TES during sleep in schizophrenic patients with an attempt to supplement the low incidence of spindles in this disease. In a study, once delta or slow waves during stage 3 sleep are detected, feedback auditory stimulation was administered that did not awaken the patient but did reduce slow waves for several minutes to temporarily improve depressive symptoms in hypersomnic-type depressive patients. As a result of reducing the “depth” of sleep, depression symptoms decreased transiently but significantly.Implantable devices for electrical stimulation of the brain have been in routine clinical use since 1997, when the first commercial deep brain stimulation (DBS) system was approved for the treatment of tremor[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R1). These DBS devices provide an invariant train of stimulatory pulses at a fixed frequency. This “open-loop” mode (meaning unidirectional signal generated from the device and delivered to the brain) of DBS therapy has proven to be effective for treatment of essential tremor[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R2), Parkinson’s disease[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R4), and dystonia. The design of a “closed-loop” implantable pulse generator (IPG) to sense and respond to physiological signals (“closed-loop” meaning bidirectional signals moving in both sensing and responding directions, allowing for the use of sensor signals to provide feedback modulation of stimulation) within or outside the brain is considered the next frontier in brain stimulation research to include new applications for neuromodulation. Implantable closed loop stimulation systems are well established also in the treatment of cardiac arrhythmias. Cardiac pacemaker devices capable of sensing and responding to atrial activity are closed loop mode cardiac stimulation devices and have been in clinical use since 1963[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R7). Whereas cardiac pacemakers detect the P-wave signal of the atrial pacemaker, brain-generated signals are statistically complex.

An understanding of the relationship between a patient’s clinical state and a neuronal signal under the influence of external stimulation is fundamental to any future utilization of the signal as a surrogate marker for clinical states that are disease specific but collectively can be categorized by pathological expressions of the disease (e.g. the magnitude of tremor) and behavioral intentions (i.e. attempting a task at hand such as walking, talking or writing). Closed-loop neurostimulation relates available neuronal recording to meaningful clinical states and uses the surrogate measurements to update neurostimulation as the device is operating.Recordable neurophysiological signals are available from multiple levels of the brain, including a single neuron, multiple individual neurons, a localized population of neurons, or a large-scale population of neurons. Single neuron recordings have been shown to be related to certain specific aspects of movement[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R10) and cognition[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R11). Technical challenges of chronic recording from single neurons exist, such as increased sampling rate requirements, difficulty maintaining recordings from the same neuron for extended periods of time, and degradation at the neuron-electrode interface contribute to the overall difficulty in maintaining sustained recordings from a single neuron. Recording from large populations of neurons, or local field potential (LFP) recordings, are much more stable over time.Oscillatory components of LFP recordings from highly specialized cortex, such as motor cortex or visual cortex, have been successfully related to clinical states such as movement and visual percepts

### Open-loop DBS is effective for treating the motor signs of Parkinson’s disease, but side effects of this therapy and its inefficiencies may be diminished within a closed loop system. Side effects of open-loop DBS experienced by some patients include impaired cognition, speech, gait and balance Open loop DBS could potentially disrupt decision making, learning, and cognitive association through its effect on LFP oscillations of the brain. Open-loop DBS therapy has been developed prior to an understanding of how LFP oscillations influence the precise timing of neuronal action potentials and influence communication between distant neuronal ensembles . Studies have demonstrated that open-loop DBS impairs learning and object-naming during stimulation of the pulvinar[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R20), and impairs verbal fluency and reactive inhibition during stimulation of the subthalamic nucleus. These impairments may be due to disruption of cortico-cortical or cortico-subcortical oscillatory synchronization between LFPs of connected brain regions[https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4058859/#R20).A central challenge for closed loop therapy is the definition of a therapeutic or optimal state that neurostimulation attempts to maintain or restore. Closed-loop systems incorporate a single or multiple set points, as reference values corresponding to the desired state of a different behavioral intention, such as walking, talking, or writing optimizing behavioral goals. The goal of closed-loop DBS in Parkinson’s disease is to restore lost functionality by stimulating the target nucleus. Stimulation of the basal ganglia is based on a “state-space model” of the basal ganglia dynamics. Stimulation is intended to force a certain feature that leads to some desired LFP reference value associated with the desired therapeutic state. The compensator attempts to bring the controlled variable closer to the desired reference value.

The “state-space model” relies on the assumption that a disease symptom is attributable to one or more features that is constant at some reference value level in a non-diseased physiological state. A model for a closed-loop system that contains multiple modes of compensation could be useful in an attempt to replicate the non-linear characteristics of the basal-ganglia system and subcortical motor network facilitating a wide range of motor and cognitive tasks.  The advantage of multiple modes of compensation compared to a single set-point closed-loop compensation system is that therapy could be tailored to an individual patient’s goals .The availability of reliably detectable bio-signals capable of driving feedback is essential to a closed-loop neuromodulation system. In current open-loop systems, the patient’s clinical status and the provider’s assessment of the clinical status via physical examination provides the feedback to regulate neuromodulation. While effective and the basis for newer neuromodulation models, this approach may be overly subjective/observer-dependent, time-intensive, overly consumptive of battery power, and may not provide patients with optimal clinical benefit.

Bio-signals for closed-loop neuromodulation would be easily detectable in a biocompatible manner, reliably recorded with limited noise and error, over an extended time (i.e. years), rich in content, and dynamically and accurately related to clinical states. For example, while functional magnetic resonance imaging (fMRI) is used extensively to study brain function, brain organization, and neural connectivity, fMRI is an impractical resource for measurable neuronal activity on an ongoing basis. On the other hand, invasive and implantable electrophysiological sensors that can detect neuronal signals on an ongoing basis would improve signal detection and feedback within closed-loop systems. Current research is focused primarily on neuroelectrophysiological signal processing; biochemical, optical, electromyographic, and mechanical signals are other potentially useful resources. Depending on the location of neuroelectrophysiological signal recording, signals may represent the activity of one neuron or an aggregate of cortical or subcortical neurons. Single-unit recordings, performed with invasive high-impedance (0.4–1.0 MΩ) penetrating microelectrodes such as those used for microelectrode recording in DBS surgery or those used with the Utah microelectrode array, detects action potentials from neighboring neurons (single or multiple). The action potential is considered the core unit of communication between neurons appealing as a potential data source for driving closed-loop systems. Recordings of single- and multi-unit neuronal activity have provided insight into patterned activity within the subthalamic nucleus and globus pallidus, and for cognitive processing and memory.

Unlike measurement of individual action potentials, LFP provides a measure of integrated population level activity, which is thought to be a combination of action potential activity, sub-threshold membrane voltage changes, and changes in glial potentials. LFP can be measured with an array of electrodes, including the same microelectrodes that are used for detection of unit activity as well as standard DBS leads and subcortical electrocorticographic strips and grids. LFPs are less susceptible to drift over time and therefore provide higher fidelity and more reliable long-term recordings, which is a desirable characteristic for a control signal. Moreover, because LFPs measure population level oscillatory activity, the data is very rich in content, both in the temporal as well as the frequency domain, providing several potential bands of interest (e.g., alpha, theta, beta, gamma, high-gamma). Because signals are recorded using invasive probes, spectral content includes very high frequencies, which are critical to the control of closed-loop systems. Within subthalamic nuclei and globus pallidus, very high frequency bands in the 200–300 Hz range and greater than 300 Hz range have been described and correlate with degree of Parkinson’s disease motor states. Investigations of LFP measured via electrocorticographic arrays in patients with Parkinson’s disease have noted increased beta band activity and synchronization within the motor cortex in patients with Parkinson’s disease compared to other patients. These studies have also shown that therapeutic stimulation in patients with Parkinson’s diseases specifically modulates aberrant beta band activity. Adaptations of DBS devices already in clinical use for invasive recording or stimulation, have simplified development of biocompatible probes for a closed-loop system.

Although measurement of unit activity and LFPs involves invasive recording approaches, non-invasive measurement of neuroelectrophysiological activity using electroencephalography (EEG) is also a consideration. A model of the brain-computer interface, the P300 speller, utilizes EEG detection of evoked cerebral electrophysiological activity to restore communication to locked-in patients. In patients with Parkinson’s disease, EEG has detected aberrant patterns of cortical activity that are potential biomarkers of the disease state. EEG essentially measures noninvasively, the same neuronal signals measured by electrocorticography. But recording electrode is further away from the electrical source and much of the higher frequency spectra (i.e., >70–100Hz) is filtered by the scalp and skull. Both of these factors contribute to a significant loss of spatial resolution. Additionally, because EEG sensors are not implanted, EEG sensors must be affixed to the scalp or skull and this may or may not be acceptable to the patient. Aside from recording neuronal electrophysiological signals, a closed-loop system utilize non-neuronal biological signals. For example, the biochemical state of various deep brain regions may be detected in real time using cyclic voltometry. Given the dopaminergic-related origins of Parkinson’s disease and biochemical basis of other neuropsychiatric diseases, the concept of integrating real-time biochemical assessments may be useful for managing dynamic fluctuations in medication effects. The groundwork for such models has begun with efforts to develop a wireless non-neuronal feedback system. Other non-neuronal biosignals given serious consideration are recording of peripheral signals by EMG and non-invasive accelerometers, because such signals indicate patient movement and clinical status in real-time. Oscillations in the motor network are related to each other through non-linear interactions. In particular, the phase of slower oscillations in the theta, alpha, and beta bands modulates the amplitude of faster rhythms in the beta, gamma and very high gamma ranges, a phenomenon referred to as phase-to-amplitude cross-frequency coupling (PA-CFC) that indicates the extent to which the phase of one oscillation extracted from a LFP determines the amplitude of another oscillation. Hierarchical relationships between oscillations play a significant role in a variety of cognitive and motor tasks and can be applied as parameters in the design of a closed-loop DBS system. A current goal in the development of closed-loop DBS systems is to discover reference points to which a controlled variable converges and thereby leads to enhancement of motor capacity.

### The objective of pattern classification is to learn a mathematical model (a classifier) that can recognize and segregate novel patterns. Pattern classification algorithms are powerful to be applied naively to data. These “machine learning” algorithms may be applied to recordings of the human voice for speech recognition, images of handwriting for association with personality, functional MRI to decode emotion evoked by facial expressions and scalp EEG to allow communication. For instance, in the case of brain computer interfaces, a classifier given a segment of recorded brain signal is able to associate the neural signal with a given state, such as emotion, thought, behavior, or intention (a “class label”). During the training phase, subjects perform activities for which the corresponding class label is known (e.g., “motor activities” class label) and the algorithm “learns” the corresponding pattern. Some classification methods used for brain signal classification, includes Support Vector Machines (SVMs), Artificial Neural Networks (ANNs), K-Nearest Neighbor (KNN), Bayesian Classification, and Hidden Markov Model (HMM). Current DBS system neurostimulation consists of a delivering a train of biphasic pulses with adjustable parameters (amplitude, pulse width, and frequency). This train is spatially applied across a cathode and an anode that are adjusted according to the size of the stimulation electrode array. The charge is deposited at the cathode, the negative pole, and the current flows from the cathode to the anode safety of the DBS is ensured because of a net-zero current application across the biphasic waveform of each pulse of the train of stimulation, use of platinum-iridium electrode material, and limiting the charge density and charge per phase to 26µC/cm2/phase and 0.018µC/phase respectively. The most work in the closed loop neurostimulation field has been done in the area of epilepsy and signal classification algorithm design for prediction of seizure onset. Such work has led to the first human implanted seizure prediction system for treatment of medically refractory epilepsy. The challenges of developing closed-loop neuromodulation systems for epilepsy, as it is with movement disorders, is identification of appropriate patient state variables to drive neuromodulatory therapy; development of informed models that accurately determine the optimal pattern of stimulation in response to patient states; and detection of reliable biomarkers indicating response to therapy.

One can foresee the application of closed loop systems to other neuropsychiatric diseases, particularly to diseases with cyclical symptom patterns, such as depression. Identification of neurophysiological biomarkers indicative of a diseased or pathological state could theoretically drive therapy parameters “on-demand.” Similarly, one could envision a system for closed-loop neuromodulation that delivers therapies coincident with memory acquisition states so as to reinforce learning.The field of closed loop neurostimulation is an interdisciplinary science incorporating disciplines of clinical neurosciences and electrical engineering. Given the importance of neuronal oscillations in the cooperative functioning of brain ensembles, the appeal for a neurostimulation system with a small electrical footprint is evident. Thus, closed loop stimulation is preferable over open loop stimulation for its less disruptive impact on cognitive processes that depend on coordinated neuronal oscillations. Closed loop stimulation strategies must target certain desirable neural states that can be restored, such as an optimal state for walking, talking, or writing. Closed loop neurostimulation systems may use physiological signals available at the site of the stimulation (e.g. LFP data), or signals that are geographically removed from the site of stimulation (e.g. ECoG or EEG data). Non-central nervous system signals are also available for use in closed loop systems, such as EMG signals, or signals from internal and external sensors (e.g. accelerometers, timing devices, or audio devices). Once these signals are measured and digitized, they must be compressed or transformed into features suitably efficient for processing by pattern classification algorithms for accurate prediction of neural patient states. These algorithms may be pre-embedded in the device or first explored within a high power computer cluster before downloading a lightweight patient-customized version into the device’s memory. Finally, the algorithm must intelligently manipulate stimulation parameters in the domains of time, frequency, or space to optimize the patient’s neurological condition.

Neuronal communication has classically been conceived of as being determined by structural

anatomical connectivity and by activity-dependent changes to the anatomical (ultra)structure of the

connection. I propose that even in the absence of changes in (ultra)structural connectivity, neuronal

synchronization as an emergent dynamic of active neuronal groups has causal consequences for

neuronal communication. If neuronal communication depends on neuronal synchronization, then

dynamic changes in synchronization can flexibly alter the pattern of communication. Such flexible

changes in the brain’s communication structure, on the backbone of the more rigid anatomical

structure, are at the heart of cognition

### Figure 2

### Fig.74.Candidate neural signals for closed loop neurostimulation systems include non-invasive electroencephalography (EEG), or invasive electrocorticography (ECoG) or local field potentials (LFP). In addition to these brain signals, the system could use electromyography (EMG), or physicals sensors such as accelerometry (not shown).

### Deep Brain Stimulation (DBS) can be classified into conventional open-loop and closed-loop adaptive paradigms. Closed-loop DBS employs a sensor to record a signal linked to symptoms while open-loop DBS does not use a sensor for recording the brain condition; therefore, stimulation parameters including duration, amplitude, and frequency of the pulse train remain constant in open-loop DBS regardless of fluctuations in the disease state. The recorded signal is known as a biomarker and can have varying nature, e.g. bioelectric, physiologic, biochemical, etc. In the open-loop DBS, a specialist tracks the patient’s clinical state and manually programs the device in a trial-and-error based manner. Adjustments of stimulation parameters are not conducted in real-time based on the ongoing neurophysiological variations in the brain; therefore, adverse effects on the patient may be induced due to the brain overstimulation. On the other hand, in the closed-loop DBS, the stimulation pulses are delivered when the brain is in an abnormal state, or they are automatically and dynamically adjusted based on the variations in the recorded signal over the time.

### figure 1

### Figure75.  [https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-017-0295-1](https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-017-0295-1#Fig1)  compares open-loop and closed-loop DBS and illustrates how they act in different brain states. Overview of open-loop DBS

### (a) versus closed-loop DBS

### (b). In open-loop DBS, a neurologist manually adjusts the stimulation parameters every 3–12 months after DBS implantation. On the other hand, in closed-loop DBS, programming of the stimulation parameters is performed automatically based on the measured biomarker.

### c Demonstration of two different brain states and the action of open-loop and closed-loop DBS. When the brain enters a specific state, it remains in that state for a short or long time. Closed-loop DBS gets deactivated when the brain enters the normal state. Open-loop DBS continues the stimulation regardless of the brain state

### figure 2

### Fig.76.a A schematic representing different brain layers and measurable electrophysiological signals. Recording from higher depths results in potentials with higher strength and quality. The higher the distance of electrode from the potential source means a larger impedance. Therefore, proportional to the distance, the potentials are attenuated and high-frequency components are rejected due to the low-pass filtering behavior of the brain layers. In addition, recording from an electrode with smaller contact area enables measuring potentials from fewer neurons .

### b Amplitude vs frequency characteristics of the human brain potentials of interest.

### c The spatial resolution of electrophysiological signals.

### d Three-shell head model. Different layers of the head, particularly the skull with a large resistivity, induce a distorting effect on the potentials that reach the scalp surface

### Neurological diseases are caused by synchronized populations of oscillatory neurons. In some patients, open-loop DBS may not yield desynchronization or its therapeutic effect may decline over time. In particular, the brain reaction to a constant set of stimulation parameters may change gradually over time due to the external (environmental) or internal (disease progress, and behavioral) factors. This procedure is called neural plasticity which is the ability of the nervous system to adopt a new functional or structural state in response to extrinsic and intrinsic factors.

### figure 5

### Fig.77. Closed-loop DBS research challenges. These challenges are classifiable in three major parts including monitoring issues (*blue part*), stimulation challenges (*yellow part*), and design expectation concerns (*red part*)

### Various stimulations, such as visual , tactile and olfactory stimulation can be introduced as substitutes for acoustic stimuli for existing closed-loop studies. Bidirectional closed-loop neurotechnologies are devices that use a neural interface to read and write information to and from the nervous system. The act of reading is a type of decoding and involves interpreting brain and nervous system signals with electrodes or other sensors that pick up the electrical impulses that neurons send.  Encoding works in the opposite direction, sending stimulus pulses into parts of the brain in order to affect a response. These processes form the so-called “closed loop.”

Researchers break down neurotechnology into three primary categories of devices, as follows:

* **Neuromodulation technology**: This category includes any devices that use a neural interface to stimulate some part of the peripheral, central, or autonomic nervous system. This type of technology can be open loop (only offering stimulation without receiving feedback) or closed loop (the stimulation parameters can be modified based on feedback responses). One application of this type of technology is neuromodulation therapy for patients with Parkinson’s disease, where sensors detect tremors, then provide appropriate stimulation to minimize or alleviate them.
* **Neuroprostheses technology**: A neuroprosthesis is any device that provides a substitute for lost sensory, motor, or cognitive functions. These devices may target either the peripheral or central nervous system. And a common example of such a device is a cochlear implant, which allows people with hearing loss to interpret sounds through the stimulation of auditory neurons in the brain stem.
* [**Brain-machine interfaces**](https://ieeexplore.ieee.org/document/7786863)**(BMIs)**: These are devices that create a direct connection between the brain and an external device (the “machine”). Some of these interfaces are unidirectional, allowing users to control an external device or receive sensory input from an external device. Others are bidirectional, allowing for both encoding and decoding to occur.

Closed-loop devices vary in their invasiveness. They can include devices used outside the nervous system with no surgical intervention, as well as devices placed intracranially or within parts of the peripheral nervous system. These devices may involve the use of electric, magnetic, acoustic, or optical signals. A [noninvasive example](https://www.frontiersin.org/articles/10.3389/fncel.2016.00092/full) would be the use of electroencephalogram (EEG) triggered transcranial magnetic stimulation (TMS). In this example, externally applied electrodes decode brain signals, and encoding occurs via external manipulation of magnetic fields over a certain brain region or regions. On the invasive end of the spectrum, [deep brain stimulation](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6015649/#:~:text=A%20closed%2Dloop%20system%20receives,parameter%20adjustment%20(Figure%205a)) (DBS) provides one of the most effective treatments for neurodegenerative diseases such as Parkinson’s disease and epilepsy. It requires placing electrodes directly into certain regions of the brain in order to provide electrical stimulation to those brain regions, as well as receive signals. The field of nanotechnology plays a role in the development of such devices because the goal is to maximize their efficacy while minimizing potential damage to neural tissue in placing the devices.A newer and potentially less invasive alternative to closed-loop DBS devices is a technique called [optogenetics](https://brain.ieee.org/newsletter/2018-issue-4/near-infrared-upconversion-optogenetics-helps-brain-stimulation-go-deep/), which provides a way to control neural activity with light and genetic engineering. By harnessing genetically encoded light-gated ion channels, researchers are able to optically stimulate target neurons. While this can also require insertion of optical fibers, in development are less invasive techniques, which involve using near-infrared light that penetrates biological tissue more easily without being scattered.

**B**enefits with closed-loop devices are the following:

* The ability to better treat neurological diseases and traumatic brain injury
* The ability to compensate for nervous system or spinal cord injury
* The ability to restore and improve [memory](https://mayoclinic.pure.elsevier.com/en/publications/closed-loop-stimulation-of-temporal-cortex-rescues-functional-net) and memory consolidation
* Improved treatment and outcomes for mental health conditions
* An increased understanding of how the brain works as a system

In the development of closed-loop devices exploration into the creation of integrated devices with complete feedback loops that can self-regulate is a highly emergent field. (451-452)

The history of neuroscience and neurotechnology goes back thousands of years. The first written records of trauma to the nervous system trace back to an [Egyptian papyrus](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989268/) from around 1700 BC. Over the centuries as science evolved, so too did the human understanding of the brain and nervous system. The 1800s and 1900s in particular were fruitful times for the fields of neuroscience, psychology, psychiatry, and cognitive science. The computer age ushered in an era of more detailed understanding, particularly from 1990 (which US President George Bush declared as the start of the “decade of the brain”) to the present due to advanced technologies such as functional magnetic resonance imaging (fMRI), which allowed for functional brain modeling, and microchips and nanotechnology, which made many early DBS therapy interventions and neuroprostheses possible.

In 2013, the Obama administration announced the [Brain Research through Advancing Innovative Neurotechnologies](https://braininitiative.nih.gov/about/overview) (BRAIN) Initiative in an effort to develop technology enabling a deeper understanding of the brain. In [alliance](https://www.braininitiative.org/alliance/ieee-brain/)with the BRAIN Initiative, [IEEE Brain’s](https://brain.ieee.org/about-ieee-brain/) mission is to facilitate cross-disciplinary collaboration and coordination to advance research, standardization, and development of neuroscience technologies to help improve the human condition.Therapeutic applications are a primary force behind much of current closed-loop neurotechnology development. This field holds significant promise in the treatment of movement disorders, spinal cord injuries, neurological diseases, chronic pain, and psychiatric disorders. As researchers develop these technologies, there is a strong drive toward decreasing invasiveness by using more advanced techniques and smaller or externally located devices. Coordinating closed-loop devices with artificial intelligence and machine learning can improve device efficacy and fine-tuning capabilities. But this further requires the ability to handle large amounts of data, making cloud computing capabilities viable for inclusion as well. The future holds promise for generalized bidirectional devices with multiple different inputs and outputs operating autonomously. Potential future applications include personalized treatment based on electrical signals and molecular physiology—for example, closed-loop bladder control in paralyzed patients—as well as treatment of complex psychological problems such as addiction, anxiety, and schizophrenia. In addition to therapeutic applications, researchers are also exploring uses in the realm of augmentation. This includes things such as memory enhancement or learning enhancement, [physical enhancements](https://brain.ieee.org/newsletter/2019-issue-2/the-possibilities-to-augment-physical-capabilities-using-brain-machine-interfaces/) in the realm of military and defense, and consumer applications in the areas of wellness and entertainment. Closed-loop neurotechnology holds significant promise for human health and wellness, among other applications. By reimagining the partnership between brain and body, it is possible to develop effective interventions for neurological and psychological disorders that historically were poorly treated with pharmaceutical or other interventions. The human brain coordinates the activity of billions of neurons to give rise to cognition and perception. Traditional attempts to understand neural mechanisms rely on observing indirect measures of neural activity when a subject performs a carefully designed, controlled cognitive task.

Electroencephalography (EEG), which measures voltages on the scalp that reflect the summation of activity of tens of thousands pyramidal cells (PCs) in the cortex provides one common tool for such observations. Many cognitive tasks elicit rich oscillatory EEG dynamics; however, correlative observational studies cannot address whether such patterns in local field potentials (and subsequently EEG) serve a mechanistic purpose or are simply an epiphenomenon not directly related to cognition. To address this issue, experimenters have used neuromodulation to demonstrate a causal role of oscillatory patterns by perturbing neural activity and observing impacts on cognitive behavior. For instance, transcranial electrical stimulation (tES) studies, in which an electric field is injected into the scalp to alter the local field potential, have been shown to affect neural oscillations important in attention and working memory. A higher intensity sinusoidal current may cause network entrainment in which external and internal oscillations synchronize. Models of coupled oscillators suggest that the frequency of the externally applied current should match the natural resonance of the internal model to best facilitate entrainment.

### The brain exhibits rich oscillatory dynamics that play critical roles in vigilance and cognition, such as the neural rhythms that define sleep. Delta rhythms are diffusely represented on a large spatial scale across the cortex. The large-scale network patterns that underlie alpha and delta rhythms, have been identified and established a novel framework for investigating multimodal, brainwide dynamics. As the brain navigates tasks and states, neurons frequently fire in synchrony, generating rich oscillatory dynamics with varied temporal and spatial distributions. Neural rhythms are particularly fundamental to the study of vigilance states and sleep, which are defined by the appearance of distinct oscillatory EEG patterns with well-studied physiological outcomes, including several forms of memory and attention, along with basic physiological processes such as brain waste clearance. The waxing and waning of neural rhythms can reflect global shifts in brain state, beyond the specific subset of neurons oscillating at a given frequency. Two neural rhythms with key relevance for the study of arousal and cognition are delta (1–4 Hz) and alpha (8–12 Hz). Alpha (8–12 Hz; [https://pmc.ncbi.nlm.nih.gov/articles/PMC10862763/](https://pmc.ncbi.nlm.nih.gov/articles/PMC10862763/#F1)) is implicated in an array of cognitive processes and maximally detected in occipital electrodes during eyes-closed wakeful rest. Delta (1–4 Hz; ) is most prominent during non-rapid eye movement (NREM) sleep and strongly linked to its cognitive benefits.

### The transformation of continuous speech into discrete linguistic representations forms the basis of speech recognition. Natural speech encodes cues at distinct timescales. Phonetic features have modulation frequencies of 30-50 Hz, syllables and words around 4-7 Hz, and phrases 1-2 Hz. These frequencies mirror frequencies of endogenous network rhythms of the brain and synaptic time constants of the underlying neural circuits. When signal and circuit rhythms are mismatched, speech identification is impaired. Compared to a baseline recurrent neural network without intrinsic oscillations, the coupled oscillatory network has significantly higher performance in speech recognition across languages, but not in the recognition of signals that lack speech-like structure, such as urban sounds.Parsing a continuous stream of speech within mixtures of unrelated sounds relies on coordinated neural processes in the brain that track temporal ﬂuctuations of the speech envelope. The auditory cortex displays characteristic patterns of neural activity,low-frequency neural oscillations (“rhythms”) in the delta (δ) and theta (θ) bands, and heightened sensitivity to stimulus modulations in this range. Temporal modulations of speech envelopes exhibit rhythms in a similar low frequency range, with envelope spectra typically peaking at aro around 4 Hz . When the envelope is artiﬁcially compressed, speech comprehension signiﬁcantly degrades, but recovers when silent gaps are inserted to restore the natural temporal structure of the signal. These observations suggest that the natural frequencies of auditory neural circuits provide a temporal scaﬀold upon which speech computations take place.

Temporally structured neural activity patterns in the brain tile a range of roughly three orders of magnitude from ultra-slow (0.01 Hz) to ultra-fast (600 Hz) oscillations. Within this broad range are ﬁve functional oscillation classes – delta (δ)theta (θ), alpha (α), beta (β), and gamma (γ) – whose interactions are presumed tosubserve various functions, including speech and language processing. It has been proposed that networks of inhibitory and excitatory neurons underlying these oscillationsgive rise to larger computational units that function as coupled harmonic oscillators. These networks of oscillators exhibit periodic (“wavelike”) behavior characterized by frequency, amplitude, and phase, with coupling strengths dynamically adjusted in response to external stimuli. Coupling between oscillators operating at diﬀerent timescales mirror hierarchical temporal information integration in the brain. Imposing oscillatory dynamics in itself is insuﬃcient for extracting task relevant structure. Rather, a match between signal and network oscillations is essential. Recognition accuracy, whereas networks with oscillations mismatched to the signal are unable to learn the task. In circuit theory, frequency matching between system and input, or resonance, imparts frequency selectivity, voltage magniﬁcation, and other signal transformations, widely used in analog communication systems. In analogy, circuit resonance in the brain has been reported in several studies, where signals arriving in phase with the natural oscillations of cortical circuits are selectively gated or ampliﬁed. In the brain, priors come encoded at birth and take the form of stereotyped circuit architectures imposed by development or particular types of dynamical response. Learning involves adapting these initial expectations to the patterns of stimuli encountered in the world. For example, in language acquisition, priors may encode general syntactic constraints, with exposure to a particular language resulting in language-speciﬁc expectations and associations with sound.

Network structure in the brain has inspired inductive biases in artiﬁcial neural networks. The topographic organization of the primary visual cortex, for example, where neurons respond selectively to localized regions of the visual ﬁeld, has motivated the use of local ﬁlters in convolutional neural networks. By enforcing spatial locality and translational invariance, these architectural choices encode knowledge essential for eﬃcient processing of visual information. Beyond this spatial organization, neural systems exhibit rich temporal dynamics, often exhibiting traveling waves of activity patterns that unfold across the cortical surface. When embedded within recurrent neural networks (RNNs), traveling waves generate dynamic representations that can be exploited for eﬃcient sequence learning, continual learning, and long-term memory consolidation. Other phenomena characteristic of coupled neural systems, including transient synchronization, phase locking, and the hierarchical nesting of oscillations, are incorporated into similar wave-based models. These wave-RNNs oﬀer new tools to artiﬁcial intelligence and serve as a platform for testing computational hypotheses about brain function. Rhythmic sensory or electrical stimulation produce rhythmic brain responses that are interpreted as endogenous neural oscillations aligned (or “entrained”) to the stimulus rhythm. The alignment of oscillatory neural activity to a rhythmic stimulus, termed “neural entrainment,” is an integral part of many current theories of speech processing. Brain responses align more reliably to intelligible than to unintelligible speech. Rhythmic electrical stimulation applied to the scalp (transcranial alternating current stimulation (tACS)) is assumed to “entrain” brain oscillations and has been shown to modulate also speech processing and perception. Rhythmic behavioural effects of tACS cannot be interpreted as evidence of entrained endogenous oscillations; they might simply reflect the impact of regular changes in current imposed onto the brain.

### Cognitive brain disorders are among the most disabling health states in the world. Existing pharmacological, surgical, and behavioral therapeutic approaches for impaired cognition are limited by heterogeneous treatment outcomes, slow symptom resolution, and accompanying risks and side effects. There is an urgent need to develop innovative and personalized therapeutic interventions that are capable of providing rapid and sustainable improvements with minimal side effects. Noninvasive neuromodulation technology is an emerging class of tools that offer such translational potential for neurocognitive disorders. Tools such as high-definition transcranial alternating current stimulation (HD-tACS) offer unprecedented control in modulating rhythmic activity in cortical regions that are implicated in neurocognitive dysfunction. Neural rhythms derive from inhibitory and excitatory postsynaptic currents and are evident as cyclic changes in the voltages of local field potentials, electrocorticograms, electroencephalograms, and magnetoencephalograms. Functionally, synchronized rhythms sculpt neurophysiological dynamics to facilitate precise and flexible communication necessary for goal-directed action and cognition. This synchronization is achieved by gating information transmission during windows of high excitability through transient, phase-coordinated local neuronal spiking within and across neuronal networks. By coordinating spike timing, synchronization increases inducing spike timing–dependent plasticity, promoting flexible cognitive function. As a result, neural synchronization is recognized as a fundamental neurophysiological process that is necessary for human cognition.

### The synchrony of neural rhythms within or between cortical regions can be changed noninvasively using tACS. This technique delivers low-intensity alternating currents on the scalp using a predetermined topographical arrangement of electrodes to induce alternating electric field gradients in a target brain region. These alternating electric fields manipulate spike timing through phase alignment of neuronal activity, without necessarily affecting the spiking rate of the neuronal population. The entrainment of neuronal activity can lead to the induction of neuroplasticity, which allows any neural and cognitive changes to persist beyond the duration of neuromodulation. Simultaneous application of two (or more) tACS currents targeted to different brain regions can be used to modulate phase synchronization among them. tACS can be used to noninvasively manipulate synchronized rhythmic activity within and between cortical networks. PAC is a well-studied neural coding motif that occurs when the amplitude of a high-frequency rhythm synchronizes with the phase of a low-frequency rhythm. This form of synchronization facilitates the integration of information across spatiotemporal scales within a nested cortical network. Local PAC deficits in the temporal cortex arise because of deficient prefrontal control marked by reduced theta-phase synchronization between the frontotemporal areas. Phase synchronization—when two or more rhythmic neuronal signals tend to cycle with consistent relative phase—is another leading neural coding motif for coordinating spatiotemporal neuronal activity. These synchronization schemes thus serve as potential targets for neuromodulation to improve memory function.

Current theories in biological psychiatry on the nature of compulsivity, including obsessive-compulsive disorder (OCD), view symptoms as outcomes of dysregulated habits and atypical reward processing due to abnormalities in cortico-basal ganglia networks. In parallel, fundamental neuroscience research has identified a neural signature in the form of medial-frontal beta-gamma rhythms, presumed to arise from the orbitofrontal cortex (OFC) during reward processing .These findings bode well for extending this personalized neuroscience intervention to people with clinical OCD and other compulsivity disorders, such as behavioral addiction (e.g., gambling, internet), eating disorders, substance use or abuse, and Tourette syndrome. Since the OFC is recognized to play a central role in the pathophysiology of mood, anxiety, psychosis, and other major categories of psychiatric disorders, the noninvasive procedure for selectively modulating OFC beta-gamma rhythms could lay the basis for future nonpharmacological therapeutics that are applicable to a wide range of psychiatric illnesses.The fields of fundamental and clinical neuroscience have made extraordinary advances in understanding the dynamic structure of the neuronal network activity that underlies cognitive function and dysfunction. Leveraging these insights has allowed to develop neuromodulation protocols, personalized to individual neurophysiology, that can selectively augment components of rhythmic cortical networks and improve cognitive function and adaptive behavior in a rapid and sustainable fashion. Personalization rooted in the neuroscience of network Dynamics, rise to the forefront of next-generation noninvasive neuromodulation and pave the way toward future use of precision electroceuticals in neurology and psychiatry.

### Breathing is a complex process that relies heavily on the coordinated action of the muscles of respiration and the control center in the brain. The respiratory center is composed of three distinct neuronal groups in the brain: the dorsal respiratory group in the nucleus tractus solitarius, the ventral respiratory group in the medulla, and the pontine respiratory group in the pons, that is further classified into the pneumotaxic center and the apneustic center. The dorsal respiratory group is mainly inspiratory, while the ventral medullary group is primarily expiratory. The rostral half of the ventral medullary group additionally contains neurons responsible for rhythm generation. The pontine groupings are responsible for modulating the intensity and frequency of the medullary signals with their pneumotaxic groups limiting inspiration and their apneustic centers prolonging and encouraging inhalation. Each of these groups communicates with one another in a concerted effort as the pace-making potential of respiration. Mechanoreceptors found in the airways, trachea, lung, and pulmonary vessels provide sensory information to the respiratory center in the brain with regards to lung volume, airway stretch, and vascular congestion. There are two primary types of thoracic sensors: slow adapting stretch spindles that conveys only volume information and rapid adapting irritant receptors that respond to irritative chemical triggers such as harmful foreign agents and dust. Both types of mechanoreceptors transmit information to the respiratory center via cranial nerve X (the vagus nerve) to increase the breathing rate, the volume of breathing, or to stimulate cough. Pulmonary stretch reflex, also called the Herring-Breuer reflex, prevents the lungs from over-inflating by sending inhibitory impulses to the inspiration center. The juxta-capillary receptors respond to vascular congestion and interstitial edema in the lungs by sending signals to the brain to increase the breathing rate.

Peripheral chemoreceptors include the carotid and aortic bodies. The carotid bodies are located at the bifurcation of the common carotid arteries and send information to the respiratory center via cranial nerve IX, the glossopharyngeal nerve. The aortic bodies are situated within the aortic arch and send information to the brain via cranial nerve X, the vagus nerve. While capable of sensing carbon dioxide and hydrogen ions, the peripheral sensory system primarily detects low arterial oxygen levels (hypoxemia). Hypercapnia and acidosis increase the sensitivity of these sensors. The carotid bodies comprise approximately 15% of the total driving force of respiration. In healthy individuals, the respiratory center is more sensitive to rising carbon dioxide sensed by central chemoreceptors than decreasing oxygen levels. Oxygen runs the respiratory center only when there is severe hypoxemia.<https://www.ncbi.nlm.nih.gov/books/NBK482414/> Central chemoreceptors in the ventral surface of the medulla and the retrotrapezoid nucleus hold most of the remaining control over the respiratory drive. They primarily sense pH changes in the central nervous system caused by alterations in arterial carbon dioxide. Carbon dioxide is a lipid-soluble molecule that freely diffuses across the blood-brain barrier and forms hydron ions within the cerebrospinal fluid. Chemoreceptors respond to pH changes as they become more acidic and send sensory input to the brain to stimulate hyperventilation. The result is a slow and deep breathing pattern that helps eliminate carbon dioxide from the body. When arterial PCO2 drops, pH in the cerebrospinal fluid becomes alkalotic, and hypoventilation ensues. Arterial PCO2 is the chief determinant of the respiratory drive under normal conditions. Respiratory centers located within the medulla and the pons are responsible for generating the baseline respiratory rhythm.

An aggregated sensory input from the peripheral sensory system monitoring oxygen levels and the central sensory system monitoring pH modifies the rate and depth of respiration. These signals, along with several other sensory inputs coming from peripheral mechanoreceptors, modulate the respiratory rhythm to create a unified neural signal sent to the primary muscles of respiration. The total input culminates in a respiratory rate of approximately 12 breaths per minute for an average adult while at rest. A variety of changes in respiratory physiology occur while asleep, especially during the rapid eye movement stage, referred to as REM sleep. During REM, breathing becomes very irregular with periods of hypopnea, apnea, and a continually changing tidal volume and respiratory rate. Paralysis of all accessory muscles of respiration ensues, and people become diaphragm dependent. Upper respiratory dilator muscles become hypotonic, leading to airway narrowing and increased airway resistance. Even though a healthy person can tolerate breathing changes during sleep, sleep becomes problematic in patients with pre-existing respiratory disease.

### Respiration is controlled through neuronal feedback loops, which are comprised of the control centre, sensors, and effectors, namely:

### • Control centre: the respiratory nuclei in the cerebral cortex and brainstem.

### • Sensors: mechanoreceptors, and peripheral and central chemoreceptors.

### • Effectors: muscles of respiration.

### The cerebral cortex, medulla and pons comprise the neural control of respiration. The cerebral cortex is responsible for voluntary control of breathing whereas the medulla and pons are responsible for automatic breathing. The nerve impulses arising from respiratory neurons in these areas regulate the activity of respiratory muscles, by activating motor neurons in the cervical and thoracic spinal cord that eventually innervate respiratory muscles.The rate and depth of breathing is controlled by the input from these areas. The physical changes in the lungs are then sensed by the mechanoreceptors and central and peripheral chemoreceptors to further adjust the breathing. The higher centre of the brain responsible for control of respiration is the cerebral cortex for voluntary control of respiration. The primary motor cortex is responsible for initiating any voluntary muscular movement, also for respiration. This function is achieved through signals that are sent to the spinal cord via corticospinal tracts and subsequently to the diaphragm and accessory muscles of respiration. The superior portion of the primary motor cortex is responsible for initiating the voluntary contraction and relaxation of the internal and external intercostal muscles.

### Controlled exhalation is regulated from the inferior portion of the primary motor cortex. The cortex contains pathways for voluntary control that bypass medullary neurons. These pathways terminate in the motor neurons innervating the respiratory muscles. Voluntary thoughts can override all the other inputs to the respiratory centre and automatic control of respiration can be disrupted without loss of voluntary control, as the two systems are separate.Voluntary control of respiration, such as breath-holding (inhibition of respiration), cannot occur indefinitely, because the chemoreceptor stimulation by hypoxaemia and/or hypercapnia overrides voluntary control. This point at which the inhibition of breathing can no longer voluntarily occur is called the breaking point. The respiratory control centre is comprised of four main anatomical areas, namely: the dorsal respiratory group (DRG) and the ventral respiratory group (VRG) located in the medulla, as well as the apneustic centre and the pneumotaxic centre which are located in the pons and are collectively called the pontine respiratory group (PRG).

### The medulla is the area of brain responsible for the respiratory pattern generation and where coordination of various voluntary and involuntary demands on respiratory activity occurs. The medullary respiratory centre is composed of two groups of neurons that are concentrated in two anatomical areas: the inspiratory centre (dorsal respiratory group) and the expiratory centre (ventral respiratory group)The apneustic and the pneumotaxic centres are neurons in the pons responsible for the modification of rhythmic discharges from the medullary neurons. They regulate the depth and rate of respiration in response to sensory stimuli or input from other centres in the brain.The pneumotaxic centre located in the upper pons interacts with the medullary respiratory centre (dorsal respiratory group) to reduce the depth of inspiration, thereby modulating the respiratory pattern. An increase in pneumotaxic output increases the rate of respiration by shortening the duration of each inhalation. A decrease in pneumotaxic output reduces the respiratory rate but increases the depth of respiration, because the apneustic centres are more active in that instance. The apneustic centre is located in the lower part of the pons. On each side of the brain stem, the apneustic centre provides continuous stimulation to the DRG. During quiet breathing, stimulation from the apneustic centre helps increase the intensity of inhalation and normally after two seconds the apneustic centre is inhibited by signals from the pneumotaxic centre. During forced breathing, the apneustic centres respond to sensory input from the vagus nerves regarding the amount of lung inflation and prevent overexpansion of the lungs by modifying the dorsal respiratory group neurons.

### The major inputs the respiratory centre are the chemoreceptors (termed chemical control of respiration), as well as several non-chemical inputs. Change in the chemical composition of arterial blood, such as a rise in PaCO2 or H+, or a reduction in PaO2 leads to an increase in the level of respiratory neuron activity. This change in chemical composition stimulates chemoreceptors and a feedback of such a change is one way through which respiration is controlled. There are two types of respiratory chemoreceptors, namely: • peripheral, and • central chemoreceptors that assist the body to control pH, PaO2 and PaCO2 in the blood. Peripheral chemoreceptors are the main influencer of respiration. These chemoreceptors located in the carotid (at the bifurcation of the carotid artery) and aortic bodies (on the aortic arch) are termed arterial chemoreceptors. The afferent impulses from the carotid bodies are carried via the glossopharyngeal nerve, whereas those from the aortic bodies are carried via the vagus nerve. They detect chemical changes in the blood; for example, if they detect a drop in oxygen, decrease in blood pH (high H+) and an increase in PaCO2, this will stimulate the chemoreceptors to stimulate the respiratory centre to increase the respiratory rate. This will then increase PaO2, neutralise the pH and clear out PaCO2. The aortic and carotid bodies are the only chemoreceptors in the body that respond to hypoxaemia. High PaCO2 stimulates both aortic and carotid bodies, the peripheral chemoreceptors are only responsible for 20% of the body’s response to hypercapnia. Low pH only stimulates the carotid bodies. Low blood pressure leads to hypoperfusion of the carotid and aortic bodies, subsequently increasing their neuronal output.

### Central chemoreceptors, that are located in the medulla, on the ventral surface, detect chemical changes in the medulla and are stimulated by a drop in cerebrospinal fluid (CSF) pH. Charged ions such as H+ and HCO3 - cannot cross the blood– brain barrier, therefore for these ions to reach the central chemoreceptors a variety of events have to occur. Carbon dioxide (CO2) diffuses from the blood into the CSF and then to the area surrounding the central chemoreceptors. CO2 then reacts with water, catalysed by carbonic anhydrase (CA) enzyme to form carbonic acid (H2CO3) which then dissociates into H+ and HCO3 - . H+ then diffuses into the chemoreceptor tissue stimulating the chemoreceptors to activate the respiratory centre and thereby increasing respiratory rate. Mechanoreceptors stimulate the respiratory centre through the lung stretch receptors and muscle spindles. The lung stretch receptors are located in the bronchial smooth muscle and they are stimulated by overinflation of the lung. The neural impulse from these receptors travels to the apneustic centre via the vagus nerve and results in a reduction in the depth of breathing. This reflex is called the Hering–Breuer inflation reflex, that occurs when the steady lung inflation results in an increase in the duration of expiration, whereas, a decrease in the duration of expiration as a result of marked lung deflation. During exercise there is a change in respiration initiated by muscle spindle activity. Impulses generated from afferent pathways of proprioceptors located in muscles, tendons, and joints stimulate inspiratory neurons during exercise and stimulate the respiratory centre to increase the respiratory rate, to help clear the carbon dioxide and acid produced by exercise and increase oxygen. Irritant receptors are located in the airway epithelium. They cause bronchoconstriction and stimulate ventilation as a protective mechanism in response to inhalation of noxious gases.

### Chemicals such as histamine also stimulate these receptors, activating rapidly adapting receptors in the trachea causing coughing, bronchoconstriction and secretion of mucus. Juxtacapillary receptors (J-receptors), located in close proximity to pulmonary vessels, are non-myelinated C-fibres in the alveolar walls. They are activated by hyperinflation of the lung, dyspnoea, bradycardia and hypotension. Intravenous or intracardiac administration of capsaicin leads to the activation of these receptors, producing a reflex response termed pulmonary chemoreflex, which is characterised by apnoea, followed by rapid breathing. Ventilation is stimulated by an increase in core temperature. The fact that pain and emotional stimuli results in hyperventilation, suggests that afferents from the limbic system and hypothalamus send signals to the respiratory neurons in the brainstem. Respiratory control involves multiple levels of regulation, including the higher, medullary and pontine centres, which provides regulatory activities that occur outside of our awareness. Chemicals such as oxygen, carbon dioxide and hydrogen ions affect breathing patterns through activation of respiratory chemoreceptors. In addition to the chemical afferent inputs to the respiratory centre, there are also non-chemical inputs that regulate respiration. Involuntary respiration is under subconscious control. The [diaphragm](https://teachmeanatomy.info/thorax/muscles/diaphragm/) and [intercostal muscles](https://teachmeanatomy.info/thorax/muscles/thoracic-cage/) are the primary respiratory muscles. They are stimulated by groups of neurons located in the [pons](https://teachmeanatomy.info/neuroanatomy/brainstem/pons/) and [medulla](https://teachmeanatomy.info/neuroanatomy/brainstem/medulla-oblongata/) and form the respiratory control centre. They send impulses to the primary respiratory muscles, via the phrenic and intercostal nerves, which stimulate their contraction. There are three main groups of neurons involved in respiration:

* The ventral respiratory group controls expiration
* The dorsal respiratory group controls inspiration
* The pontine respiratory group controls the rate and pattern of breathing

Once the neurons stop firing, the inspiratory muscles relax and expiration occurs. The respiratory control system, like other regulatory systems, can be thought of as being composed of a controller and a controlled system. The controller, in the case of the respiratory system, consists of respiratory neurons in the central nervous system, particularly in the medulla and pons, which direct the activity of the respiratory muscles, and chemoreceptors and mechanoreceptors that inform these neurons of the results of their activity. The controlled system is made up of skeletal muscles in the thorax and abdomen that pump air into and out of the lungs and, skeletal smooth muscles that regulate the ease of air passage through the tracheobronchial tree. The respiratory control system is intimately and extensively cross-linked with other systems that regulate the circulation, nutrient intake, temperature homeostasis, and locomotion. Two main control systems regulate respiratory muscles . One exerts unconscious, autonomic, and continuous control of respiration meeting the body’s metabolic demands. This pathway comprises the brainstem, reticular formation, pons, and medulla. The other system, comprising sensorimotor and limbic forebrain structures , facilitates the top-down control of respiration, allowing among other functions to coordinate speech and complex motor acts.

### A widespread cortico-limbic network actively tracks human breathing. Activation of olfactory and limbic regions, including the amygdala and hippocampus, aligns with the inspiration phase of the respiratory cycle. Voluntary control of breathing engages primary sensory and motor cortices, the supplementary motor area, cerebellum, thalamus, caudate nucleus, and globus pallidum, bilaterally, as well as the medulla. Breathing is modulated by covert motor behavior, for instance during imagery and listening to music. People tend to align their breathing with a perceived musical rhythm as a form of respiratory entrainment. The phase-alignment with external stimuli influences visuo-spatial and memory performance. Psychophysical states can modulate breathing. For instance, states of anxiety, depression, anger, stress, and other negative or positive emotions are linked to specific respiratory patterns and conscious control of breathing, for example, slowing, can induce changes in HR variability and in brain activity. This evidence points to an active interface of psychophysical states, breathing, and cognitive function. The alternation of systole (ventricular contraction) and diastole (ventricular relaxation) gives rise to the cardiac cycle and the heart rhythm. The heartbeat (HB) does not display the regularity of a metronome but rather acts more like a dynamic pacemaker driven by both sympathetic(acceleration) and parasympathetic (vagus) nerves. Research shows that noradrenergic neurons in the locus coeruleus may influence neurovascular coupling and cerebral blood flow from health to pathology. (453-455)

### Neurovascular coupling reflects the close temporal and regional linkage between neural activity and cerebral blood flow. The neurovascular unit (NVU), which is an integrated and interactive entity comprised of three major components:

### (1) the cerebral vascular cells (vascular smooth muscle cells (VSMCs; pericytes and endothelial cells),

### (2) the astrocyte and micro glial cell, maintains the blood-brain barrier (BBB), a crucial structure for brain homeostasis that tightly controls the tarnsport of molecules and immune cells into and out of the central nervous system. (CNS). Breakdown of the BBB is evident in disease and results in exposure of brain tissue to harmful blood components such as fibrinogen and albümin, which can exacerbate or cause neurological function.

### (3) Neurons are integral within the NVU as the driving agents initiating increases in CBF during functional hyperemia, and as the cells that consume most of the energy used by the brain and interact with astrocytes, microglia, and blood vessels, and their communication at each of these interfaces influences how the

### NVU responds to neural activity to induce NVC and mediate changes in CBF. The large increase in blood flow relative to the metabolic needs of the tissue exists to wash away metabolic by-products such as carbon dioxide and lactate or is a result of the consequent acidosis. The increased blood flow serves as a sink for the heat generated during intense brain activity. Neuronal activity can trigger local changes in CBF directly by releasing vasoactive molecules onto arterioles to engage VSMCs or indirectly via signaling to astrocytes, which then release vasoactive molecules onto capillary pericytes. Neuron-derived vasoactive molecules include cyclooxygenase-2-derived prostanoids and nitric oxide (NO). Projection neurons from subcortical regions such as the basal ganglia (e.g., cholinergic neurons) and brainstem nuclei (e.g., noradrenergic neurons in the locus coeruleus) can also regulate cortical blood flow by mediating widespread change in vascular tone and modulating local NVC response via their actions on cortical neurons, astrocytes, and the vasculature. The relative contributions of excitatory and inhibitory neurons to NVC support a potentially more important and predominant role for inhibitory neurons particularly NO synthase-positive interneurons

### Though neural cells and the vasculature have distinct embryonic origins, they have intertwined time courses of proliferation, migration and terminal differentiation and a common array of signaling molecules that regulate both brain and vascular development. Vascular endothelial cells synthesize brain derived neuronal groth factor (BDNF) to precisely guide the migration of adult neuronal progenitors from the subventricular zone to the olfactory bulb. Vasculature-derived signals can drive proper neuronal migration and positioning, while neural activity can drive proper branching and vascular patterning. NVU development depends on reciprocal feedback signaling between blood vessels and astrocytes. Astrocytes are required for proper blood vessel density and branching throughout development, and inhibition of astrogliogenesis leads to a significant decrease in vessel density and branching in both the cortex and the retina. Astrocyte and cortical vessel development coincide and are interdependent, and the mechanisms driving NVC can vary as the system matures. Microglia play a role in vasculogenesis and use blood vessels as migration highways in the developing brain. Modulations in neuronal activity cause changes in local blood flow mediated by transmission through the astrocyte. This interaction is termed “neurovascular coupling,” which describes coupling between neuronal activity and the vasculature. The neuron alters vascular tone independently of astrocytic mediation, and these two cells play a synergistic or antagonistic role depending on the physiological environment. Signals generated by neurons, astrocytes and endothelial cells engage the vasomotor apparatus to induce vasodilatation, reduce vascular resistance and increase blood flow.

### Neurovascular coupling (NVC), which mediates rapid increases in cerebral blood flow in response to neuronal activation, is used to map brain activation or dysfunction. Human brain functional imaging uses functional hyperemia, a rapid and local increase in blood flow, to map brain regions activated by sensory stimulation and behavioral tasks, as well as assess brain connectivity. The signaling pathways by which neurovascular coupling (NVC) generates functional hyperemia, involve the cooperation of numerous cell types, and are triggered by neurotransmitter feedforward mechanisms rather than from local metabolic feedback due to acute oxygen and glucose consumption, or CO2 production (456-460)

### Evidence highlights a specific phase relationship between the cardiac cycle and information processing. Visual perception is modulated by HB-locked neural responses, the so-called heartbeat-evoked potential (HEP). HEP modulated both early (P50) and later (N100, P300) event-related potentials (ERPs) of the EEG in response to somatosensory stimuli . Somatosensory stimuli are better detected during diastole than systole and inversely related to the amplitude of the preceding HEP, similarly to what has been observed for visual stimuli . This link is bi-directional, as cognitive functions such as attention, emotional processing, and social cognition, as well as the underlying brain activity, similarly impact interoception and HEP. According to a dominant perspective on brain function, the brain is constantly predicting what will happen next . When these predictions fail, certain brain regions respond to the error. These same brain regions are involved in detecting bodily states, which suggests that the tendency to change one’s behavior might be sensitive to visceral sensations . Research suggests that brain activity, cognition, and behavior are modulated by bodily rhythms and sensory accuracy and speed vary between the systole and diastole phases of the cardiac cycle. In the context of classical conditioning, presenting an auditory warning signal at the diastole phase (during expiration) rather than the systole phase (during inspiration) enhances the probability that the signal will evoke a learned defensive reflex.The effects of cardiac cycle phase on cognition and behavior are related to interoception, the conscious or subconscious sense of the internal state of one’s body.

### Interoception is quantified as the magnitude of the HEP of the electroencephalogram (EEG), that reflects processing of cardiac activity in the neocortex, which is dependent on the insula especially. The brain responds differently to external and internal signals during the diastole and systole phases. Specifically, exteroceptive signals may be more heavily weighted during the diastole phase and interoceptive signals more heavily weighted during the systole phase. External feedback from the error may be combined with interoceptive signals in the brain, which, shape predictions and behavior to minimize errors in the future. A study in skilled musicians reported that behavioral adaptations following an error are smaller if the mistake took place during systole rather than diastole, despite larger error-related event-related potentials at systole compared with diastole. Cardiac-movement effects have been attributed to [baroreceptors](https://www.sciencedirect.com/topics/neuroscience/baroreceptor), located within the [aortic arch](https://www.sciencedirect.com/topics/neuroscience/aortic-arch), the stretch receptors, the [carotid sinuses](https://www.sciencedirect.com/topics/neuroscience/carotid-sinus) and the coronary arteries, represent the key communication channels between the heart and the brain. Baroreceptors are active during systole, conveying information on the timing and strength of the heartbeat to the central [nervous system](https://www.sciencedirect.com/topics/psychology/nervous-system) via the vagal and [glossopharyngeal nerves](https://www.sciencedirect.com/topics/neuroscience/glossopharyngeal-nerve), but are quiescent during diastole when there is no such information to convey. The heart's rhythmicity is modified by humoral and neural factors and the heart period can be increased or decreased according to signals conveyed by vagal and sympathetic efferents. There is a closed loop communication reflex mediated by baroreceptors that allows the timing of the heart cycle to be controlled. Interoceptive signals, particularly those originating from the heart, have been purported to play a role in [social cognition](https://www.sciencedirect.com/topics/neuroscience/social-cognition) .

In order to understand another's behavior, we simulate their perceptual, motor, and bodily states in ourselves. A good model should contain information pertaining not only to the expected position of the body in space, and afferent tactile feedback from the effector, but also the somatovisceral conditions that would be generated by the execution of that action. These predicted conditions can then be used to infer the causes of another's behavior, based on the causes of those conditions in the self. Including interoceptive information in predictive models may provide unique information about others' [affective states](https://www.sciencedirect.com/topics/psychology/emotion), not otherwise accessible through exteroceptive and prioprioceptive inference alone, due to the ubiquitous role of somatovisceral states in emotion and feeling states.Findings of resonance beyond the central nervous system suggest that this mirroring effect extends into the [peripheral nervous system](https://www.sciencedirect.com/topics/neuroscience/peripheral-nervous-system). Both external stimuli such as observing someone perform an action, and internal stimuli, such as mentally rehearsing an action, can elicit [autonomic system](https://www.sciencedirect.com/topics/psychology/autonomic-nervous-system) activity. Watching an actor lift a weight or run on a treadmill produces changes in the respiration rate of an observer, such that it increased linearly with effort. These findings support the idea that bodily systems involved in interoception may be candidates for resonance. The direct matching mechanism proposes a match between the conditions of action execution and observation. If this mirroring effect does extend to the interoceptive system, any relationship between the cardiac cycle and movement timing found during action execution should be found during action observation.

One consequence of resonance may be interpersonal coordination. Research in the field of social [neuroscience](https://www.sciencedirect.com/topics/psychology/neuroscience) has found both movement and cardiac coordination between interacting individuals. In the movement literature, interpersonal coordination may refer to either mimicry or synchronization. A distinction is made based on the temporal relations of the interacting individuals, with mimicry reflecting non-periodic matched movements and [synchronicity](https://www.sciencedirect.com/topics/psychology/synchronicity) used to describe movements temporally matched in time. Studies reported that listeners to a speaker tend to move in time with rhythms of a speaker's speech and mirror the postures of the speaker. In other interactions, the direction of the effect is less apparent, with partners mimicking each other's' postural sway and linguistic forms. In a study, groups of subjects (numbering between four and five individuals) constructed models out of Lego blocks and they either worked collectively (where subjects took turns to work on one construction project) or individually (where subjects worked on their own construction projects side by side). More stable shared heart rate dynamics were observed in collective trials than individual trials, increasing across the course of collective trials suggesting that convergence was tied to the social nature of the task.

Heart rate entrainment has been suggested as a mechanism underlying emotional commonality in [social interaction](https://www.sciencedirect.com/topics/neuroscience/social-interaction), facilitating a sense of community between individuals empathy and team performance. A study in which pairs of expert improvisers were asked to mirror each other's movements found that periods of both increased kinematic and subjective togetherness were characterized by higher heart rates and greater inter-player correlation of heart rate. Findings of interpersonal coordination and its influence on measures of social competence are compatible with the hypothesis that resonance supports action understanding. The mutual prediction of each other's' actions is thought to facilitate joint coordinated action and the achievement of shared goals . There is evidence to suggest that shared representations of action form automatically even when no joint action is required and it would be more effective to ignore the other person. Cardiac-movement [synchronicity](https://www.sciencedirect.com/topics/psychology/synchronicity) may support the interpersonal coordination that underlies joint action, through physiological attunement. Such coordination may serve as “social glue”, fostering feelings of group belonging and closeness**.** The systolic and diastolic phases of the cardiac cycle affect perception and cognition differently. Higher order processing tends to be facilitated at systole, whereas sensory processing of external stimuli tends to be impaired at systole compared to diastole. Peripheral [physiological processes](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/physiological-process), such as the cardiac cycle, impact the individual's ability to appropriately exert control over [behavior](https://www.sciencedirect.com/topics/neuroscience/behavior-neuroscience) and emotional responses. Future work should seek to investigate whether inter-dyad factors such as inter-individual liking and physical similarity to one's partner or individual differences such as [personality traits](https://www.sciencedirect.com/topics/neuroscience/personality-traits), are predictive of the cardiac-movement coordination effect.

### Cognitive-emotional control constitutes the basis for mental well-being and [social interactions](https://www.sciencedirect.com/topics/neuroscience/social-interaction). There is converging evidence showing that physiological arousal represents a major influence on an individual's ability to appropriately exert control over [behavior](https://www.sciencedirect.com/topics/neuroscience/behavior-neuroscience) and emotional responses. The physiological signals, such as cardiac rhythm have been suggested to represent an important source of information about internal physiological arousal affecting emotionally salient content. Cardiac phase can affect [executive functions](https://www.sciencedirect.com/topics/psychology/executive-functions) such as [inhibitory control](https://www.sciencedirect.com/topics/psychology/inhibitory-control), sensorimotor stimulus-response conflict processes as well as facial emotion perception and memory for affective content. Processing emotionally conflicting content and overcoming emotional incongruence requires the allocation of *cognitive* control resources to relevant *emotional* information to reduce the effect of distracting irrelevant emotional information. Cognitive-emotional conflict triggers control processes which can be examined using face-word Stroop paradigms. Behavioural performance decreases (longer reaction times and decreased accuracy) in emotionally conflicting trials, compared to non-conflicting/congruent trials. There is converging evidence that cognitive-emotional control processes can be modulated by heartbeat-related signals to be mediated via [baroreceptors](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/baroreceptor), that are attached to stretch- and pressure-sensitive [sensory neurons](https://www.sciencedirect.com/topics/neuroscience/sensory-neuron) found in blood vessels conveying information about timing, strength and frequency of the heartbeat to the [brain](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/protocerebrum)  .

### Information about the rate at which the heart muscle contracts (ventricular systole) and relaxes (ventricular diastole) is sent to the brain via afferent (interoceptive) pathways and is integrated within frontal, parietal and [insular cortices](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/insular-cortex) , a route via which information about bodily states is integrated with external information to select behavioural responses possibly mediated via PFC regions. Investigations into associated neurophysiological correlates of cardiac autonomic activities have shown that midline frontal theta oscillations as measures by EEG are modulated by cardiac arousal state. Theta oscillations play an important role for higher-order response selection and cognitive control processes. The cardiac-cycle affect oscillatory (theta) neural activity in [frontal cortices](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/frontal-lobe) to integrate information of autonomous arousal states during response selection.

### Bayes theorem suggests that in estimating the probability of any event, one should consider the current evidence for that event but also the prior knowledge about the event. Hierarchial predicitve processing provides a framework otlining how prior expectations shape perception and cognition. Predicitve procesing theory translates the insight to cognition, specifically focusing on perception. In this framework, a perceiver has an internal model of the outside world and continously updates this model based on new information. Any perceptual process, where the organism acquires new information about the outside world in the form of sensory information, results in an inference about the cause of that sensory data, a so-called *posterior*. Each *posterior* is a combination of the *likelihood* and *prior*. The *likelihood* is a representation of the data sampled in the sensorium, which includes both the sensory input and an estimate of the reliability of that sensory data. The *prior* is the initial prediction (before any sensory information is encountered) about the cause of the sensory data. The prior is often shaped by memory and previous experiences. (461-464)

### In hierarchical predictive processing— active inference under deep generative models—there are priors at every level of the implicit model. Prior beliefs, known as ‘empirical’ priors depend upon experience and they are updated by evidence from lower levels. This is reflected in the description of belief updating, which uses today’s posteriors as tomorrow’s priors. Priors can be held with greater or lesser precision. A very precise conviction or commitment to a prior belief (e.g., innate subpersonal priors that underwrite homeostasis) is less amenable to updating. Prior beliefs at higher levels are held with less precision or confidence and more amenable to updating, through perceptual inference, or long-term revision, learning and experience-dependent plasticity. Both anatomical and functional studies have shown that the cortex is organized as a hierarchyPredictive processing assumes that the trade-off between priors, likelihood, and posteriors is all done in the service of minimizing prediction error—the divergence between expected and sampled sensory data. In this process, the brain generates a model of the world in the service of prediction error minimization. The modeling of the world is generative in the sense that it optimizes the inferred causes of sensory signals based on experience and internally generates a set of predictions (priors) about what kinds of sensory encounters it is likely to sample thereafter. Hierarchical predictive processing (or coding) is also known as active inference and is distinguished from predictive coding accounts of perceptual synthesis by emphasizing the enactive and situated aspect of sense-making (e.g., active vision or, more generally, active inference that involves active sampling of the sensorium). Predictive processing has been applied to understand a range of cognitive processes, from psychiatric disorders to emotion perception. A growing body of research suggests that perceptions (even if incorrect) depend upon prior learning and local context. For example, seeing lips move a certain way makes people likely to hear a word even if there is no actual audio input. (465-466)

### Hearing a tone alongside a visual stimulus makes people more likely to report hearing the tone alongside the visual stimulus even if it no longer remained. Improved discrimination is predicted by increased power of the posterior alpha band, suggesting that the previously learned knowledge tuned the brain for future perception (via modulation of alpha-band oscillations), which attenuated early visual attention and thus perception. Ascending prediction errors are conveyed by fast gamma activity while descending predictions are mediated at slower frequencies. Prior expectations can have a large effect on perceptual processing and expectations, (i.e., priors) can result in perceptions not afforded by the actual sensory data, meaning people can see or hear things that are not actually present.Not only person-level knowledge that influences early perception, social knowledge about others can modulate how individuals from that stereotyped group are subsequently perceived and acted toward. Social knowledge can be based on explicit information about other individuals, such as group membership. Stereotypes and prejudices held toward other groups can alter even the earliest phases of intergroup perception. Dynamic ınteractive theory of personal construal (DIPT) built on ideas fro connectionism and dynamical systems theory, assumes that perception of others is gradually buit up via cyclical interaction between categories, high level cognitive states and the low level processing of facial, vocal and bodily cues. Once a perceptual cue is presented, it begins a cascade of interaction between neural nodes of mutual inhibition and excitation taht encode social categories. The influential predictive coding theory suggests that the brain predicts and attenuates responses to rhythmically regular signals to optimize resource allocation to non-predicted sensory input. The perception of sensory input oscillates at the HR, leading to the suppression of activity in response to events that fall on the low-excitability phase in the heart cycle. The ‘neural subjective frame’ suggests that (pre-attentive) updating of internal body states modulates self-awareness and sensation.

### Simulation theory (ST) is an approach to the question of how people attribute mental states to others. Mental-state attribution is variously called ‘folk psychology’, ‘theory of mind’, ‘mind reading’, or ‘mentalizing’. It is a species of ‘metarepresentation’, an activity in which mental states (beliefs) represent other mental states. Since the early 1980s, three principal approaches to mind reading have dominated the field. The first approach, theory theory (TT), holds that people somehow acquire a ‘theory’ of the mental realm, analogous to their theories of the physical world (‘folk physics’). This theory posits causal links between environmental inputs, inner states, other inner states, and behavioral outputs. Given information about another person’s observed behavior or facial expression, etc., attributors make theoretical inferences to his/her mental states A second approach to mind reading, rationality theory, holds that people use principles of rationality to attribute mental states to others. According to this theory, mind readers make a default assumption that others are rational in matters of belief, preference, and decision making. ST, the third approach says that people employ imagination, mental pretense, or perspective taking (‘putting oneself in the other person’s shoes’) to determine others’ mental states. A mentalizer simulates another person by first creating pretend states (e.g., pretend desires and beliefs) in his/her own mind that correspond to those of the target, then inputs these pretend states into a suitable cognitive mechanism, which operates on the inputs and generates a new output (e.g., a decision). This new state is taken ‘off line’ and attributed or assigned to the target.Interpersonal or intrapersonal types of simulation are considered in the cognitive domain. Interpersonal simulation involves other-directed simulation (e.g., empathy or third-person mind reading). Intrapersonal simulation involves self-directed simulation. One example of intrapersonal simulation is the construction of visual imagery. When visualizing, one attempts to reproduce or ‘reexperience’ episodes of genuine vision. Visualization is an attempt to generate a mental state that occurs, or might occur, in one’s own mind. The method of attempted generation in this case is endogenous rather than exogenous (it omits stimulation of the receptors).

### ‘mirror neurons’ or ‘mirror processes’, discovered in the laboratory of Rizzolatti in Parma, are a class of neurons, initially found in the premotor cortex of macaque monkeys, that are activated both when a monkey performs a specific goal-oriented action and when it simply observes another monkey (or human) performing the same action. Premotor activation can be considered the neural basis of an intention to perform a motor act, for example, grasping an object. Since the same intention is experienced by both the performer and the observer of the action, neurons with this execution–observation matching property are called ‘mirror neurons’. The process by which mirroring is effected may be called a ‘mirror process’ or a ‘resonance process’. Since the observer reexperiences the same motor intention as the performer, a mirror process is an interpersonal simulation process (a ‘low-level’ one). Humans have also been found to possess motor mirror systems. In humans, the (motoric) mirror neuron system is composed of regions in the posterior inferior frontal gyrus (IFG), the ventral premotor cortex, and the rostral inferior parietal lobule (IPL). The terms ‘mirror system’ and ‘mirror neuron’ are primarily applied to motoric systems and motoric neurons. Motoric areas are not the only portions of the brain that house mirroring, or resonance, systems. Analogous systems are found for experiences of pain, touch, happiness, and disgust. In each of these cases, under appropriate observational conditions, an experience in one person is mirrored, or reexperienced, in an observer.

### The terms ‘experience’ and ‘reexperience’ do not refer to conscious experiences. Most mirroring events (at the observer’s end) occur below the threshold of consciousness, and can be detected only by brain-oriented techniques, such as functional magnetic resonance imaging (fMRI).An interesting departure from this rule occurs in a patient who suffers from a hyperactive mirror system for touch; when she observes another person being touched, she consciously experiences touch in herself, as if she were being touched. Action mirroring is the automatic and mandatory duplication of an observed action in the observer’s own motor system. This automatic mirroring, or resonance, leads to an understanding of the target’s action in terms of a motor code. Pronouncing a word form requires activation patterns in (frontal) articulatory motor systems of the speaker and leads to specific (temporoparietal) activation of auditory and somatosensory systems due to self-perceived sounds and movements. Fronto–temporal connections are typically left-lateralized, so the left hemisphere takes a lead role in mapping correlated articulatory–auditory information. Correlations between word and sound-, smell-, taste-, or action-related information lead to the establishment of embodied referential semantic circuits, including perisylvian neuronal populations, along with circuits in auditory, olfactory, gustatory, and motor cortex.

### Uses of simulation are to project the self into the past and the future. Projection into the past is referred to as episodic memory and projection into the future is called prospection. Humans are capable of mental time travel, or mentally transporting themselves into the personal past or future. This mental time travel is similar to high-level simulational mind reading in at least two respects. First, the mental time traveler detaches himself/ herself from the present environment or the present moment and endeavors to reexperience his/her past or preexperience her/his future. This is analogous to the simulational mind reader, who tries to detach himself/herself from his/her own genuine mental states and project himself/herself into the mental states of another. Second is an attempt to flexibly recombine details from past events into a ‘construction’ of either the personal past, the personal future, or the states of another.

### Episodic memory is for personally experienced events. There are at least three dimensions of resemblance between processes involved in remembering previously experienced events (retrieval processes) and processes involved in the original experiences of the events (remembered processes): (1) phenomenological resemblances, (2) neural resemblances, and (3) functional resemblances. According to memory theorists, an essential feature of episodic memory retrieval is that it is accompanied by autonoetic consciousness that is a conscious feeling of reexperiencing or reenacting a previously experienced event. Memory processes are, characterized in terms of their phenomenological resemblance to remembered processes. A single-cell recording study suggests that neurons activated during perceptual experiences are selectively reactivated during recall of those experiences. The fact that reenacting these postures and eye movement patterns at retrieval increases retrieval speed and accuracy suggests that they play a similar function in remembering such experiences and perceptions. Simulational processes resemble—or aim to resemble—the processes they simulate.

### In mental simulation, the content arises from its neyral resemlance to the object of representation. This resemblance emerges through distinct patterns of brain activation that mimic the mental state or action being simulated. The variability in species composition among a set of sampling sites, or beta diversity, is considered a key signature of the ecological processes that shape the spatial structure of species assemblages. This variability can be decomposed into three additive components: i) the standard similarity in the (relative) abundances of species among sites, ii) the degree of functional dissimilarity between individuals of distinct species among sites, and iii) the degree of functional similarity between individuals of distinct species among sites, or beta redundancy. These three components can be used to portray the functional resemblance among sites on a ternary diagram related to various aspects of taxonomic and functional variability among sites to community assembly processes more completely than just looking at individual components. Unlike standard similarity/dissimilarity coefficients which possess a simple binary structure, the increased complexity of functional resemblance arises from the relaxation of the constraint that all species are equally and maximally distinct.

### The brain constructs representations of what is sensed and thought about in the form of nerve impulses that propagate in circuits and network assemblies (Circuit Impulse Patterns, CIPs). CIP representations of which humans are consciously aware occur in the context of a sense of self. The sense of self must be contained in patterns of nerve impulses. An embodied sense of self is generated and contained as unique combinatorial temporal patterns across multiple neurons in each circuit that contributes to constructing the sense of self. CIPs, representing the sense of self can be learned from experience, stored in memory, modified by subsequent experiences, and expressed in the form of decisions, choices, and commands. The selfhood CIP patterns only have to represent the self and not directly represent the inner and outer worlds of embodied brain, the self representation should have more degrees of freedom than subconscious mind and therefore have some capacity for a free-will mind of its own. Column activity oscillates at different frequencies. The important function is the interplay of columns that is governed by shifting degrees of oscillatory synchrony.

### Cortical columns can be mutual regulators. Clusters of adjacent columns can stabilize and become basins of oscillating attraction, and the output to remote regions of cortex can facilitate synchronization with distant basins of attraction. Control in such a system is collective and cooperative. Elemental cortical circuit design includes recurrent excitatory and inhibitory connections within and between layers. Most of the excitatory drive is generated by local recurrent connections within the cortical layers, and the sensory inputs from the outside world are relatively sparse. Weak sensory inputs are amplified by local positive feedback. Inhibitory circuits are crucial for controlling oscillations and time-chopping of impulse traffic, both within and among columns. Some 10-20% of all synapses in neocortex are thought to be inhibitory. Neocortex generates multiple-frequency oscillations so that information flows best on every half cycle. If the impulse activity of multiple neurons in a given column could be recorded simultaneously, then the possibilities for combinatorial coding in a given column can be examined as it changes with mental state. Combinatorial coding, as a principle, operates with certain neural processes, such as taste and odor perception. An argument for combinatorial coding is well established for gene expression in which traits depend on many genes. Phase-locking of single units to oscillations seems to be a pre-requisite for successful memory. Neocortical architecture suggests that its CIP representations either enable conscious awareness or are themselves the essence of consciousness. CIPs, though essential, are themselves dependent on biochemical processes such as neurotransmitter systems. A conscious mind could emerge when subconscious mind achieves a certain “critical mass” of distributed circuit activity that becomes interlinked and coordinated in a unique way. This created conscious mind then becomes available to enrich the processing of subconscious operations. Conscious mind is not aware of the processes of subconscious activity but is aware of the consequences of such activity.

The subconscious mind has another source of programming. Conscious mind, that provides a new dimension for actively programming the subconscious is the brain’s way of intervening with itself. This goes to the heart of the biological case for free will and personal responsibility. The representations of self may not be devoted to the external and internal worlds of embodied brain, as required of the representations of subconscious mind. A degree of free will may be enabled. The brain not only contains CIP representations of things we have experienced, but also can create CIP representations of things and events that we have never experienced. Creating a representation of things never seen nor experienced requires reconstituting in unique ways the CIP representations of things we have seen or experienced. The brain can control its own consciousness.The process could operate at both subconscious and conscious levels. The difference for conscious mind, is that conscious mind does not “see” the original stimulus, but mainly “looks in on” the CIP representation being held in subconscious mind (sCIPs). Conscious mind contains CIP (cCIP) representations of another sort. The brain creates a separate conscious mind that is representation of self-identity, as opposed to representations of external world. Self-awareness of consciousness is constructed, rather than emergent. Thus, the sense of self-identity can grow with time, being modified by biological maturation and learning experience, resulting in evolving CIP representations.

One may be tempted to conclude that consciousness is a figment of our imagination. Our sense of individual identity really does exist, presumably in the form of CIPs. , which are themselves very real and subject to biological forces, so called mentalistic forces, mediated by CIPs. Consciousness depends on large-scale cortical network synchronization in multiple frequency bands (not just the ever-popular 40 Hz). Oscillation coupling determines which neuronal assemblies communicate at any particular instant, and thus the brain can re-wire itself dynamically on a time scale of milliseconds without any need for changing synaptic hardware. A change in frequency allows various neuronal assemblies to process information with minimal cross interference and even neurons or mini-columns to participate in different macro-assemblies simply by changing frequency and coherence coupling.The brain produces a range of long and short thoughts which may operate like “frames” of a motion picture. The frames arise from activity in neurons as they interact in oscillatory fashion within and across their local networks. These frames, separated by interludes of less neuronal participation, are concantenated to produce a stream of thought. Certain kinds of frames give rise to consciousness. Conscious thought arises when the cortical columns creating the frames become sufficiently cross-linked and coordinated.More evidence comes when changing the CIPs, either through disease or through some external manipulation, changes the state of consciousness. For instance, massive cerebral strokes may wipe out conscious responsiveness to stimuli from large segments of the body. Injection of a sufficient dose of anesthetic produces immediate change in neural activity and unconsciousness ultimately follows. Naturally occurring epilepsy causes massive, rapid bursts of neural activity that wipe out consciousness. Even during the “auras” that often precede an epileptic attack, there are localized signs of epileptic discharge and the patient is consciously aware that a full-blown attack may soon ensue.

### Conscious mind monitors and adjusts as necessary its representation of itself. It also monitors some of the CIP representations of subconscious mind, but presumably has no direct access to the operations of unconscious mind. The representations of self in conscious mind can do other free-will kinds of things, such as reflect on what it knows, plans, decides, and vetoes. Conscious mind is a “mind of its own.”Brains construct representations of what they detect and think about. The representations take the form of patterned nerve impulses propagating through circuits and networks (circuit impulse patterns, CIPs). This representational scheme has been unequivocally demonstrated for both non-conscious and subconscious minds. Conscious mind must be a CIP representation, but the constructed representations are of a sixth sense of self, an awareness of embodied self and what the self encounters and engages. This mind may automatically know what it is knowing. The brain creates a CIP representation of its embodied self using visual, tactile, and proprioceptive sensations and a representation of personal space that includes a representation of the self in three dimensional space. Long-term memory stores this representation and it is released for operation and updating whenever consciousness is triggered. The brain may switch attention from interoceptive to exteroceptive signals, and this transition parallels HEP modulations.

### Oscillations during interoception (35–110 Hz) differ markedly from those during exteroception (1–35 Hz) in the insula, amygdala, somatosensory cortex, and inferior frontal gyrus. Exacerbated HEP modulations are observed in disease associated with dysregulated behavior, impaired cognition, and atypicalities in brain volume and connectivity of allostatic networks . These findings highlight bidirectional influences between heart activity, brain function, and behavior. Visceral signals are constantly processed by our central nervous system, enable homeostatic regulation and influence perception, emotion and cognition. Internal bodily signals, like cardiorespiratory ones, ared constantly transmitted from the body to the brain ensuring self regulation of the organism. Subcortical brain regions are particularly important for this body-brain communication.Our brain continuously receives signals originating from visceral organs providing a moment-by-moment sense of the physiological condition of the body. Such monitoring of bodily organs ensures the stability of the organism through regulation of homeostatic reflexes and adaptive behavior. Beyond its function in homeostasis, visceral processing and the perception of the physiological condition of the body (i.e., interoception) are increasingly recognized to impact cognitive, social, and affective processes and to be a prominent feature of several psychiatric disorders.

Rrespiratory signals have also been shown to modulate brain oscillations at rest in widespread brain networks. Similarly to cardiac signals, respiration has also been shown to influence a range of cognitive and motor processes. Slow (~0.2 Hz) respiration-entrained oscillatory activity has been reported in the human limbic system. Major brainstem and midbrain centers are involved in the processing and regulation of cardiac and respiratory signals for homeostasis and control of adaptive behavior. The heart rate variability (HRV)—the fluctuation in the time intervals between consecutive heartbeats—is an important physiological marker, in cardiac physiology, of heart–brain interactions, and a useful tool to assess sympathetic and parasympathetic influences on disease states.The peripheral autonomic nervous system (ANS) adjusts the heart rate (HR) to intrinsic and extrinsic demands. It is controlled by a group of functionally connected brain regions assembling the so-called central autonomic network (CAN). More specifically, forebrain cortical regions, limbic and [brainstem](https://www.sciencedirect.com/topics/neuroscience/brainstem) structures within the CAN have been identified as important components of circuits involved in HR regulation.

The activity of the heart, despite being equipped with intrinsic automaticity, is influenced by almost all the other organs of the body. Body signals shape the workload of the heart in order to meet changing needs of the entire organism. The two peripheral branches of the ANS, the parasympathetic and the sympathetic system, modulate the intrinsic activity of the cardiac pacemaker cells in the sinoatrial node. While the parasympathetic or vagal activity reducing energy expenditure is anabolic and health promoting, the sympathetic branch is needed for an adequate stress response. The heart rate and its variability mirror the resulting homeostasis of an organism influenced by physical as well as by psychological variables in a certain environment. A complex system is needed to orchestrate the autonomic function of the body to meet all internal and external needs. Based on animal experiments, Benarroch coined the term “central autonomic network” (CAN) in 1993 in order to describe a group of forebrain, limbic and brainstem regions involved in the generation of an adequate autonomic functional state . There is strong evidence to assume that different heart rates can be associated with changes in the functional coupling between CAN regions.

Heart rate response to physiological stressors and the associated recovery patterns provide reliable indicators of both autonomic function and cardiovascular (CV) risk . Orthostatic challenge (standing up) is a physiological stressor which involves baroreflexes, via baroreceptors, blood pressure, and heart rate response. The baroreflex is involved in the regulation of blood pressure, by controlling heart rate and modulating parasympathetic and sympathetic outflow. Seconds after standing, the heart rate increases due to abrupt inhibition of vagal activity via the baroreflex. Peak heart rate is reached at about 10 seconds through a product of vagal inhibition and sympathetic stimulation. Heart rate rapidly decelerates after this, coupled with a stabilization of arterial pressure and vagal reactivation. The speed of heart rate recovery is a measure of homeostatic flexibility (or adaptive capacity to withstand and respond to stressors) of the CV system, in addition to neuromuscular, vascular and cardiopulmonary baroreflexes, systems which contribute to orthostasis. Attenuated heart rate recovery is associated with increased risk of CV events and with all-cause mortality . It is attributed to dysfunction of vagal and sympathetic activation.

A growing body of multidisciplinary research describes the central autonomic network and brain-heart axis co-ordinating physiological response to orthostatic challenge. A complex matrix of receptors and neurotransmitters driving anticipatory, inhibitory and stimulatory functions contributes to central autonomic control . Several densely connected cortical and subcortical regions known as the “brain rich club” and forming the allostatic interoceptive network, are believed to provide the neural framework which facilitate the integration of task and time dependent functions observed during orthostasis. These hub regions involved with central baroreflex-mediated autonomic regulation include the superior parietal, superior frontal, cingulate cortices, and precuneus, basal ganglia, insula, hippocampus, amygdala, thalamus, and cerebellum. Experimental studies have highlighted the role of thalamic function in pre-excitation of motor pathways and anticipation of movement. The thalamus may be central to maintaining optimal autonomic control and the complex autonomic response to standing.

Tissue volume in the thalamus reflects cortico-thalamic connectivity and the number of neurons in topographically connected thalamic and cortical regions are closely related. There is emerging evidence suggesting that thalamic atrophy and associated loss of thalamic integrity and functional connectivity may reflect CV function. Acute thalamic injury and chronic neurodegeneration are associated with cardiac dysfunction and impaired CV capacity. Loss of thalamic volume and reduced functional connectivity are associated with high-risk phenotypes for sudden cardiac death in epilepsy and schizophrenia. Slow heart rate recovery, is a risk factor for sudden cardiac death. Loss of thalamic structural integrity and functional connectivity may be a contributor to risk patterns associated with slow heart rate recovery. Experimental evidence and imaging studies highlight the importance of thalamic structural integrity and functional connectivity in association with motor, cardiopulmonary, and allostatic interoceptive function. The finding that thalamic pre-excitation and activation are primary steps in both motor and sensory responsiveness highlights thalamic function as a potential rate limiting step in the integration of physiological response to orthostatic challenge. The wider subcortical analysis which identified associations between hippocampal and amygdala volume with heart rate recovery highlights that the thalamus is not an isolated neural hub but there is a central autonomic network. Thalamic nuclei are densely connected with neural hubs within the brain rich club and higher cortical networks. Hippocampal volume is known to decline rapidly with advancing age and targeting hippocampal neuroplasticity is a primary strategy to promote cognitive function and prevent dementia. Thalamic volume has been identified to decline earlier in the life-course. Thalamic atrophy is a risk factor for cognitive decline and a 1 cm3 reduction in thalamic volumes has been associated with twofold increased risk of dementia. (467-470)

### The Heartbeat Evoked Potential (HEP) - obtained by averaging surface EEG signals time-locked to heartbeats - which has been associated with widely distributed cortical sources over frontal, central and parietal regions, has been linked with cardiac function but also with various cognitive and affective processes. Respiratory signals have also been shown to modulate brain oscillations at rest in widespread brain networks . Similarly to cardiac signals, respiration has also been shown to influence a range of cognitive and motor processes Major brainstem and midbrain centers are involved in the processing and regulation of cardiac and respiratory signals for homeostasis and control of adaptive behavior. The heart rate variability (HRV) – the fluctuation in the time intervals between consecutive heartbeats – is an important physiological marker, in cardiac physiology, of heart-brain interactions, and a useful tool to assess sympathetic and parasympathetic influences on disease states

### Heart rate variability (HRV) time- and frequency-domain parameters, which reflect the state of the autonomic nervous system, are used to evaluate the balance of the sympathetic–parasympathetic nervous system, assess general well-being, mental and physical stamina, and the life expectancy of a person . HRV is a potential biomarker of sudden unexpected death in epilepsy (SUDEP). Reduced HRV is associated with maladaptive responses to mental and physical stress, shortened life expectancy, and an increased risk of SUDEP, arrhythmia, sudden cardiac death, acute myocardial infarction, and diabetic neuropathy. Reduced heart rate variability can be an early sign of autonomic dysfunction in neurodegenerative diseases and may be related to brain dysfunction in the central autonomic network. The autonomic nervous system (ANS) connects the body’s nervous system to the main physiological systems, and is modulated by reflex loops, the hypothalamic and brainstem centers and the afferent and efferent pathways. The baroreflex and chemoreflex loops –bıth autonomic cardiovasvcular reflexes , involve pathways from baroreceptors and chemoreceptors to central processes and subsequently teh sympathetic and parasympathetic motor arms. Modulation of higher barin structures mediates cardiovascular responses. Brain imaging and electrophysiological studies have demonstrated the involvement of certain subcortical and cortical regions, including the amygdala and the midcingulate and insular cortices, enabling integration of simple (e.g.sensory) and complex (e.g.emotional) information in autonomic cardiovascular activity.

### Cardiac activity is controlled by the sympathetic and parasympathetic systems which induce herat rate oscilaltions at difefrent rhythms. Mathematical methods (e.g.time and frequency-domain analysis) are used to study these rhythms and autonomic cardiac modulations , including time and frequency domain analysis. Autonomic cardiac activity depends on reflex loops , hypothalamic –brainstem structures and various somatic and visceral information. Sympathetic activity is underpinned by a neuronal network in the rostral ventrolateral medulla, spinal cord, and hypothalamus (paraventricular nucleus and lateral hypothalamus). Parasympathetic activity is underpinned by neurons in the nucleus ambigus and dorsal motor nucleus of the vagus nerve . These centers receive inputs directly or via the solitary tract nucleus, from stretch-sensitive afferents of ventilation (lung afferents), arterial pressure (carotid and aortic receptors) afferents, muscle receptor afferents activated by stretch and metabolites, chemoreceptor afferents activated by hypoxia and hypercapnia, and inputs from somatic and visceral afferents . Imaging studies showing core brain regions involved in ANS control revealed differential contribution of subcortical and cortical regions to autonomic cardiac control according to autonomic arousal tasks (somatosensory, motor, emotional, cognitive). A “central autonomic network” (CAN) has emerged, reproducible mainly in the amygdala, insular, and midcingulate cortices. The ANS is controlled by different regions involved in identifying, storing, and regulating emotions .

FIGURE 1

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### Fig.78.

### Modulation of cardiac activity during wakefulness: reflex loops [baroreflex (BaroR), respiration (Resp), chemoreflex (ChemoR)] including brainstem centers (BS) and central autonomic network including midcingulate cortex (MCC), insula (INS), amygdala (AMY) contribute to cardiac activity, leading to increased heart rate (HR), increased sympathetic activity (SNS), and decreased parasympathetic activity (PNS).

### Modulation of cardiac activity during non-REMS: The drop in brain activity, with predominant contribution of reflex loops on ANS activity, leads to decreased HR, with parasympathetic predominance, and decrease in sympathetic modulation.

### Modulation of cardiac activity during REMS: autonomic cardiac regulation is shared between central control in relation with the insula and amygdala and homeostatic control of the cardiovascular system by reflex loops, leading to decreased HR with sympathetic predominance and decreased parasympathetic activity. Red circles indicate increase and blue circles decrease in autonomic cardiac activity.

### Although cardiac activity is modulated through reflex loops and hypothalamic brain stem centers, the CAN appears responsible for rapid changes in behavior related autonomic activity , particularly sensory, emotional and cognitive dimensions. The highest levels of sensory and emotional information are integrated by autonomic cardiac activity. HRV allows an integrated examination of the interactions between peripheral processes ofv cardiac autonomic modulation reflex loops and central information processing systems , including emotions.HRV analysis can be used to chaarcterize sympathetic and parasympathetic hyperactivity or hypoactivity in many psychiatric disorders. Anxiety and depressive disorders are associated with sympathetic overactivity, and anxiolytic and antidepressant treatments are known to affect ANS control. HRV can be a pharmacological or psychotherapeutic aid to reduce the trial and error and side effects of pharmacological treatments designed to restore ANS activity.

### The brain controls the heart directly through the sympathetic and parasympathetic branches of the autonomic nervous system, which consists of multi-synaptic pathways from myocardial cells back to peripheral ganglionic neurons and further to central preganglionic and premotor neurons. Cardiac function can be profoundly altered by the reflex activation of cardiac autonomic nerves in response to inputs from baro-, chemo-, nasopharyngeal and other receptors as well as by central autonomic commands, including those associated with stress, physical activity, arousal and sleep. In the clinical setting, slowly progressive autonomic failure frequently results from neurodegenerative disorders, whereas autonomic hyperactivity may result from vascular, inflammatory or traumatic lesions of the autonomic nervous system, adverse effects of drugs and chronic neurological disorders. Both acute and chronic manifestations of an imbalanced brain–heart interaction have a negative impact on health.

### Cardiac function can be profoundly altered by the reflex activation of cardiac autonomic nerves in response to inputs from receptors including baroreceptors, chemoreceptors, receptors from skeletal muscles and nasopharyngeal receptors. Cardiac sympathetic and parasympathetic nerve activities are reciprocally altered in response to baroreceptor stimulation, whereas in response to stimulation of chemoreceptor and nasopharyngeal inputs, both cardiac sympathetic and parasympathetic activities are increased.The physiological advantage of reciprocal baroreflex control of the heart by sympathetic and parasympathetic nerves is that it allows for rapid and large compensatory responses to perturbations in blood pressure. The physiological cardiac response to the chemoreceptor reflex has the advantage of maximizing oxygen conservation, while at the same time maintaining an adequate perfusion pressure for the brain and the heart. This is achieved by a vagally evoked bradycardia (which reduces cardiac oxygen consumption), while co-activation of cardiac sympathetic outflow maintains an optimum stroke volume and cardiac output to meet the essential metabolic needs of the brain and heart . The diving reflex is the most powerful autonomic reflex known, as it is associated with intense sympathetically mediated vasoconstriction and profound vagally mediated bradycardia. Like the chemoreceptor reflex, it has the effect of conserving oxygen during submersion. Physical exercise, either dynamic or static (isometric), entails a decrease in HP, which is abrupt in onset, maintained or even enhanced while exercise occurs, and progressively reversed after exercise is over. The changes in HP at the onset and offset of exercise result primarily from parasympathetic withdrawal and reactivation, respectively . During steady-state dynamic exercise, the decrease in HP results from a continuum of balanced sympatho-vagal control, with parasympathetic withdrawal playing the greater role the lower the workload. These autonomic changes result from the integration of the baroreceptor and exercise pressor reflexes with central autonomic commands.

### Neurodegenerative disorders frequently cause slowly progressive failure of the autonomic control, mainly concerning its sympathetic component, resulting in multiple clinical manifestations (orthostatic hypotension, impaired sweating, neurogenic bladder with erectile dysfunction in men, gastrointestinal dysmotility), which may be subtle due to compensatory mechanisms. Vascular, inflammatory or traumatic lesions of the autonomic nervous system and drug adverse effects manifest acutely with signs of autonomic hyperactivity, including abnormal excessive control of the cardiovascular system. Sustained and chronic autonomic hyperactivity may appear in association with other chronic neurological disorders, in particular sleep disorders. Both acute and chronic manifestations of an imbalanced brain–heart interaction represent a risk factor for the development of cardiovascular diseases or acute cardiovascular events, which can lead to sudden cardiac death.Autonomic hyperactivity is characterized by excessive sympathetic activation, either in isolation or in association with excessive parasympathetic activation. Excessive sympathetic activity may result from activation of descending sympathoexcitatory pathways, disinhibition of sympathoexcitatory reflexes , sympathetic activation by hypoxia or ischaemia , loss of baroreflex buffering  or loss of inhibitory GABAergic control at diencephalic , brainstem or spinal levels . Sympathetic overactivity is thought to be the common phenomenon that links the major cardiac pathologies seen in neurological catastrophes .

### When physical or psychological stressors challenge the body, a transient sympathetic overactivity, mainly with active coping mechanisms, is adaptive as part of the short-term survival machinery. This has been referred to as ‘allostasis’, which is the re-establishment of homeostasis through change in the level of operation of the physiological system. By contrast, chronic stress states produce passive or withdrawal coping mechanisms and elicit a long-term autonomic response referred to as a ‘hyperarousal state’, characterized by chronic sympathetic and hypothalamo-pituitary–adrenocortical system activation. The consequences of overactivity of the allostatic systems are referred to as ‘excessive allostatic load’, which is maladaptive and leads to chronic diseases.HR modulates thalamic activity, resulting in global brain and cognitive effects ranging from emotion regulation to attention and working memory performance. HR accelerates during inspiration [respiration rate (RR) decreases] and slows down during expiration (RR increases). These fluctuations of HR in relation to the breathing cycle are part of the phenomenon known as HR variability and are influenced, among other factors, by the baroreflex and the sympathetic nervous system. The HR depends on breathing rhythms and tidal volume (depth of ventilation) and relates to breathing cycles approximately with a 4:1 ratio (four HBs within one respiration cycle). (471-474)

### The electroencephalogram (EEG) as a complex signal, is an important brain state indicator (e.g. waking, sleep, seizure). Modern brain research is intimately linked to the feasibility to record the EEG and to its quantitative analysis. EEG spectral analysis (decomposing a signal into its constituent frequency components) is an important method to investigate brain activity. The electroencephalogram (EEG; brain waves) can be recorded by electrodes placed on the scalp. It is a complex signal resulting from postsynaptic potentials of cortical pyramidal cells. Crucial aspects of the signal may not be recognized by visual inspection of the EEG. Additional quantitative analysis is fundamental to investigate the EEG in more detail. EEG activity reflects the temporal summation of the synchronous activity of millions of cortical neurons that are spatially aligned. EEG waveforms may be characterized based on their location, amplitude, frequency, morphology, continuity (rhythmic, intermittent or continuous), synchrony, symmetry, and reactivity The conventional bandwidth of clinical EEG focuses on the analysis of waveforms ranging from 0.5Hz to 70Hz. EEG waveforms can be characterized by various types:-

1. Infra-slow oscillations (ISO) (less than 0.5Hz): ISOs are the dominating frequency in the preterm neonates is as low as 0.01 to 0.1 Hz and are termed as spontaneous activity transients (SAT). SATs represent endogenously driven, the spontaneous activity which is crucial in shaping neuronal connectivity at an early immature stage where sensory input has little or no role at all.<https://www.ncbi.nlm.nih.gov/books/NBK539805/>  Additionally, ISOs at a wide range of frequencies (0.02 to 0.2 Hz) are also present during non-REM sleep, phase synchronized with higher frequency EEG activities.<https://www.ncbi.nlm.nih.gov/books/NBK539805/>

2. Delta (0.5 to 4Hz): Delta rhythm is physiologically seen in deep sleep and is prominent in the frontocentral head regions. Pathological delta rhythm presents in awake states in case of generalized encephalopathy and focal cerebral dysfunction. Frontal intermittent rhythmic delta activity (FIRDA) presents in adults,<https://www.ncbi.nlm.nih.gov/books/NBK539805/>  whereas occipital intermittent rhythmic delta activity (OIRDA) occurs in children.<https://www.ncbi.nlm.nih.gov/books/NBK539805/>  Temporal intermittent rhythmic delta activity (TIRDA) is frequently seen in individuals who have temporal lobe epilepsy.<https://www.ncbi.nlm.nih.gov/books/NBK539805/>

3. Theta (4 to 7Hz): This is the rhythm which is brought on by drowsiness as well as early stages of sleep such as N1 and N2. It is most prominent in the fronto-central head regions and slowly migrates backward replacing the alpha rhythm due to early drowsiness. Heightened emotional states can also enhance frontal rhythmic theta rhythm in children and young adults. Focal theta activity during awake states is suggestive of focal cerebral dysfunction.

4. Alpha (8 to 12Hz): The posterior dominant alpha rhythm is characteristically present in normal awake EEG recordings in the occipital head region. It is the defining feature of the normal background rhythm of the adult EEG recording. The posterior rhythm attains the alpha range of 8Hz at the age of 3 years and does not decline even until the ninth decade of life in healthy individuals. Slowing of the background alpha rhythm is considered to be a sign of generalized cerebral dysfunction.<https://www.ncbi.nlm.nih.gov/books/NBK539805/> The amplitude of alpha rhythm varies in different individuals as well as at different times in the same individual. It is best seen with the eyes closed and during mental relaxation and is characteristically attenuated by eye-opening and mental effort. In diffuse encephalopathy, patients may portray generalized-alpha activity which is non-reactive to internal or external stimuli and goes by the name of "alpha coma."

Mu rhythm is another type of alpha rhythm which presents in the central head regions, and they have an arch like morphology. This rhythm characteristically disappears with the motor activity of the contralateral limbs or thinking about initiating motor activity. It is relatively unchanged with eye-opening. Attenuating factors include fatigue, somatosensory stimulation, and mental arithmetic. They are quite asymmetric and asynchronous on the two sides.

5. Sigma waves: This activity is seen physiologically in N2 sleep and is called sleep spindles or sigma waves. They may be slow (12 to 14Hz) or fast (14 to 16Hz) and are seen most prominently in the fronto-central head regions. Pathological spindle rhythm can be seen in generalized encephalopathy and is known as "spindle coma."

6. Beta (13 to 30Hz): Beta rhythm is the most frequently seen rhythm in normal adults and children. It is most prominent in the frontal and central head regions and attenuates as it goes posteriorly. The amplitude of beta activity is usually 10 to 20 microvolts, which seldom increase above 30 microvolts. It often increases in amplitude during drowsiness, N1 sleep and subsequently decreases in N2 & N3 sleep. Most of the sedative medications such as barbiturates, chloral hydrate, and benzodiazepines increase the amplitude and quantity of beta activity in individuals.<https://www.ncbi.nlm.nih.gov/books/NBK539805/>  Focal, regional or hemispheric attenuation of beta can occur with a cortical injury, malformations, subdural, epidural or subgaleal fluid collections.

7. High-Frequency Oscillations (HFOs) (greater than 30Hz): These further classify as gamma (30 to 80Hz); ripples (80 to 200Hz) & fast ripples (200 t o500Hz). Gamma rhythm has been attributed to sensory perception integrating different areas.  Epileptic foci are known to generate episodes of very high-frequency activity. Intracranial depth recordings from the epileptic hippocampus (animal and human models) have reported ultrafast frequency bursts (fast ripples), which probably correlate with the local epileptogenicity of the brain tissue.<https://www.ncbi.nlm.nih.gov/books/NBK539805/> There is evidence for interictal HFOs as possible biomarkers of human epileptogenic brain tissue.

Ultrafast EEG activity correlates to cognitive states and event-related potentials.   There are reports of HFOs (greater than 200 Hz) related to somatosensory stimulation or motor movements and their sensitivity to vigilance states, motor interference or pharmacological manipulations, such as anesthetics or sedatives offer newer options for brain monitoring and diagnostics.  They may help in early detection of demyelination and other disorders of cortical integrity.

### The human alpha rhythm is defined as oscillations in electric potential within the 8- to 12-Hz range, normally recorded as sinusoidal waves with larger amplitudes over posterior regions, present in roughly 95% of healthy adults, especially during eyes-closed rest. This electrical potential is believed to arise from the oscillation of postsynaptic potentials in the neocortex . Functionally, alpha has been interpreted as an idling rhythm that diminishes when eyes are opened or during mental activity. Alpha band activity (8-13 Hz) is not only suppressed by sensory stimulation and movements but also modulated by attention, working memory and mental tasks and could be sensitive to higher motor control functions. “alpha activity” (encompassing frequencies between 8 and 12 Hz) in the resting EEG during relaxed wakefulness and sleep spindles in the nonREM sleep EEG are rhythmic. Spectral analysis, which decomposes a signal into its constituent frequency components, is an important method to investigate brain activity. It has been known that human brain waves become slower and increase in amplitude during the transition from waking to sleep and even more in deep sleep .

### A night of sleep is divided into two states, rapid eye movement (REM) and non-REM sleep, based on visual inspection of the EEG, EOG and EMG. REM sleep occupies 20 - 25 % of sleep in human adults, and is characterized by rapid eye movements, which occur phasically under closed eyelids, in conjunction with a loss of muscle tone. Autonomic nervous activity shows increased variations that are manifested as fluctuations in heart rate, blood pressure and respiration. Non-REM sleep is traditionally subdivided into stages 1 to 4 with stages 3 and 4 referred to as slow wave sleep (N3 according to new scoring rules) . Slow waves (defined as waves encompassing frequencies below 4.5 Hz) during non-REM sleep have proven to be valuable markers of sleep intensity, and indirectly, of sleep need. The cyclic alternation of the two basic sleep states (nonREM sleep and REM sleep ) is one of the hallmarks of sleep.

### In human adult the nonREM-REM sleep cycle exhibits a periodicity of 90 - 100 min. Assessment of EEG variables by computer-aided methods of signal analysis, such as spectral analysis, provides complementary information to sleep stages. Spectral analysis is a mathematical approach to quantify the EEG. It does not provide a biophysical model of EEG generation. Its purpose is the decomposition of signals such as the EEG, into its constituting frequency components. The fast Fourier transform (FFT; ) is a widely applied method for obtaining the EEG spectrum. EEG signals are electrical potential differences that vary continuously over time. For data processing with a digital computer, signals need to be digitized. Analog-to-digital (A/D) conversion involves spectral analysis that describes the frequency content of a signal based on a finite set of data. The power density spectrum or power spectrum displays the distribution of power or variance over the frequency components of a signal. It is defined as the Fourier transform of the autocorrelation function.Each phase and stage of sleep includes variations in muscle tone, brain wave patterns, and eye movements. The body cycles through all stages approximately 4 to 6 times each night, averaging 90 minutes for each cycle. Sleep quality and time spent in each sleep stage may be altered by depression, aging, traumatic brain injuries, medications, and circadian rhythm disorders. The duration spent in each sleep stage evolves as individuals age, often reflecting a decline in the overall biological necessity for sleep in individuals over time.

Newborns and Infants (Birth to 1 Year)

Sleep timing in newborns is distributed evenly across day and night for the first few weeks of life, with irregular sleeping and waking patterns. Newborns sleep approximately 16 to 18 hours per day discontinuously, with the longest continuous sleep episode typically lasting 2.5 to 4 hours. Newborns have 3 different types of sleep: quiet sleep (similar to NREM), active sleep (similar to REM), and indeterminate sleep. In contrast to children and adults, newborn sleep onset occurs through REM, not NREM, with each sleep episode consisting of only 1 or 2 cycles.

Circadian rhythms develop around 2 to 3 months of age, with greater durations of waking hours during the day and longer periods of sleep at night. At 2 months of age, the progression of nocturnal sleeping begins. By 3 months of age, the cycling of melatonin and cortisol in a circadian rhythm occurs, and sleep onset begins with NREM. REM sleep decreases and shifts to the later part of the sleep cycle. The total NREM and REM sleep cycle is typically 50 minutes instead of the adult 90-minute cycle. At 6 months of age, the longest continuous sleep episode lengthens to 6 hours. At 12 months, infants typically sleep 14 to 15 hours daily, with most sleep occurring in the evening and only 1 to 2 naps needed during the day.<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

Toddlers (Ages 1 to 3) and Children (Ages 3 to 9)

Around 2 to 5 years of age, the total sleep time needed each day decreases by 2 hours, from 13 to 11 hours. By 6 years of age, children manifest circadian sleep phase preferences and tend toward being night owls or early risers.

Adolescents (Age 10 to 18)

The total sleep time required for adolescents is 9 to 10 hours each night. Due to various pubertal and hormonal changes accompanying puberty's onset, slow-wave-sleep and sleep latency time declines, and time in stage N2 increases. Around mid-puberty, daytime sleepiness occurs more frequently than at earlier puberty stages.<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

Adults (Age 18+)

Adults tend to demonstrate earlier sleep time, wake time, and reduced sleep consolidation. Adults aged 65 and older awaken approximately 1.5 hours earlier and sleep an hour earlier than adults aged 20 to 30.<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

Gender Differences

Men tend to spend a greater amount of time in stage N1 sleep and experience more nighttime awakenings, so there is a greater propensity for daytime sleepiness. Women maintain slow-wave sleep longer than men and tend to complain more often of difficulty falling asleep. Additionally, daytime sleepiness increases during pregnancy and the first few months postpartum.<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

The circadian rhythm regulates the sleep cycle, which is driven by the suprachiasmatic nucleus (SCN) of the hypothalamus. GABAergic sleep-promoting nuclei are found in the brainstem, lateral hypothalamus, and preoptic area.<https://www.ncbi.nlm.nih.gov/books/NBK526132/> Transitions between sleep and wake states are influenced by multiple brain structures, including:

Hypothalamus: controls onset of sleep

Hippocampus: memory region active during dreaming

Amygdala: emotion center active during dreaming

Thalamus: prevents sensory signals from reaching the cortex

Reticular formation: regulates the transition between sleep and wakefulness

Pons: helps initiate REM sleep.

The extraocular movements that occur during REM are due to the activity of PPRF (paramedian pontine reticular formation/conjugate gaze center). The sleep cycle is regulated by the circadian rhythm, which is driven by the SCN. The circadian rhythm also controls the nocturnal release of adrenocorticotropic hormone (ACTH), prolactin, melatonin, and norepinephrine (NE).<https://www.ncbi.nlm.nih.gov/books/NBK526132/> The primary value of sleep is to restore natural balance among neuronal centers, which is necessary for overall health. The current hypotheses as to the function of sleep include:

1. Neural maturation
2. Facilitation of learning or memory
3. Targeted erasure of synapses to "forget" unimportant information that might clutter the synaptic network
4. Cognition
5. Clearance of metabolic waste products generated by neural activity in the awake brain
6. Conservation of metabolic energy<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

Sleep occurs in five stages: wake, N1, N2, N3, and REM. Stages N1 to N3 are considered non-rapid eye movement (NREM) sleep, with each stage leading to progressively deeper sleep. Approximately 75% of sleep is spent in the NREM stages, with the majority spent in the N2 stage. A typical night's sleep consists of 4 to 5 sleep cycles, with the progression of sleep stages in the following order: N1, N2, N3, N2, REM. A complete sleep cycle takes roughly 90 to 110 minutes. The first REM period is short, and as the night progresses, longer periods of REM and decreased time in deep sleep (NREM) occur.

Wake/Alert

EEG recording: beta waves - highest frequency, lowest amplitude (alpha waves are seen during quiet/relaxed wakefulness)

The first stage is the wake stage or stage W, which further depends on whether the eyes are open or closed. During eye-open wakefulness, beta waves predominate. Alpha waves become the predominant pattern as individuals become drowsy and close their eyes.<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

N1 (Stage 1) - Light Sleep (5%)

EEG recording: theta waves - low voltage

This is the lightest stage of sleep and begins when more than 50% of the alpha waves are replaced with low-amplitude mixed-frequency (LAMF) activity. Muscle tone is present in the skeletal muscle, and breathing occurs regularly. This stage lasts around 1 to 5 minutes, comprising 5% of total sleep time.

N2 (Stage 2) - Deeper Sleep (45%)

EEG recording: sleep spindles and K complexes

This stage represents deeper sleep as the heart rate and body temperature drop. The presence of sleep spindles, K-complexes, or both characterizes it. Sleep spindles are brief, powerful bursts of neuronal firing in the superior temporal gyri, anterior cingulate, insular cortices, and thalamus, inducing calcium influx into cortical pyramidal cells. This mechanism is integral to synaptic plasticity. Sleep spindles are essential in memory consolidation, specifically procedural and declarative memory.

K-complexes are long delta waves that last approximately one second and are known to be the longest and most distinct of all brain waves. K-complexes are shown to function in maintaining sleep and memory consolidation. Stage 2 sleep lasts around 25 minutes in the first cycle and lengthens with each successive cycle, eventually comprising about 45% of total sleep. This stage of sleep is when bruxism (teeth grinding) occurs.

N3 (Stage 3) - Deepest Non-REM Sleep (25%)

EEG recording: delta waves - lowest frequency, highest amplitude

N3 is also known as slow-wave sleep (SWS). This is considered the deepest stage of sleep and is characterized by signals with lower frequencies and higher amplitudes, known as delta waves. This stage is the most difficult to awaken from; for some people, loud noises (> 100 decibels) will not lead to an awake state. As people age, they spend less time in this slow, delta-wave sleep and more time in stage N2 sleep. Although this stage has the greatest arousal threshold, if someone is awoken during this stage, they will have a transient phase of mental fogginess, known as sleep inertia. Cognitive testing shows that individuals awakened during this stage tend to have moderately impaired mental performance for 30 minutes to 1 hour. This is the stage when the body repairs and regrows tissues, builds bone and muscle, and strengthens the immune system. This is also the stage when sleepwalking, night terrors, and bedwetting occur.<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

REM (25%)

EEG recording: beta waves - similar to brain waves during wakefulness

REM is associated with dreaming and is not considered a restful sleep stage. While the EEG is similar to an awake individual, the skeletal muscles are atonic and without movement, except for the eyes and diaphragmatic muscles, which remain active. However, the breathing rate is more erratic and irregular. This stage usually starts 90 minutes after the sleep state, with each REM cycle increasing throughout the night. The first cycle typically lasts 10 minutes, with the final cycle lasting up to 1 hour.<https://www.ncbi.nlm.nih.gov/books/NBK526132/> REM is when dreaming, nightmares, and penile/clitoral tumescence occur.

Important characteristics of REM:

* Associated with dreaming and irregular muscle movements as well as rapid movements of the eyes
* People tend to awaken spontaneously in the morning during an episode of REM sleep
* Loss of motor tone, increased brain O2 use, increased and variable pulse and blood pressure
* Increased levels of ACh
* The brain is highly active throughout REM sleep, increasing brain metabolism by up to 20%<https://www.ncbi.nlm.nih.gov/books/NBK526132/>

The clinical evaluation of sleep is performed using a polysomnogram, a procedure that utilizes an electroencephalogram (EEG), electrooculogram, electromyogram, electrocardiogram, pulse oximetry, airflow, and respiratory effort. These tests are performed overnight and usually require a minimum of 6 hours of monitoring. Specifically, an EEG records brain wave patterns via small electrodes placed on the scalp. A polysomnogram is the gold standard test for diagnosing sleep-related breathing disorders such as obstructive sleep apnea, central sleep apnea, and sleep-related hypoventilation or hypoxia. A polysomnogram may also be used to evaluate nocturnal seizures, periodic limb movement disorder, narcolepsy, and REM sleep behavior disorder.Sleep EEG is a good example for state‐dependent frequency changes. Alpha slows down and disappears as dominant oscillation before the onset of sleep. After sleep onset (except REM sleep), two brain oscillations are dominant, slow oscillations (SO) of about 0.75 or 0.8 Hz , and spindle oscillations with a mean spindle frequency (SF) of about 13 Hz. None of the frequency ratios between these oscillations (neither SF/HR ~ 13, nor SF/SO ~ 17, or HR/SO ~ 1.3) represent binary multiples, they rather suggest phase de‐coupling between frequencies. Amplitude coupling, plays an important role during sleep in human subjects. Amplitude coupling between SO, SF, and ripples in hippocampus, is associated with memory consolidation. (475-476)

The similarity in the frequency architecture may be the reason that sound plays a vital role for inducing emotional feelings and emotional communication via music. Choir singing is a good example. Psychophysiological studies on singing show that song structure, breathing and HRV are coupled. The song structure determines the time windows for breathing (i.e., for inhaling and exhaling) and, as a consequence, drives HRV. The hearts of singers become synchronized, they accelerate and decelerate at the same time. Well-documented physiological effects of singing include the strengthening of respiratory muscles and the optimization of breathing, as well as an increase in the concentration of oxytocin and endorphins, which is considered indicative of improved immune defense and well-being. Similarly, a reduction in general physiological tension and an increase in heart rate have also been observed. An open-ended survey with a qualitative evaluation revealed positive effects on breathing and lung function, posture and body control, relaxation and stress, and energy level within a sample of choral singers. The human voice has a relevant emotional value itself and it works as an emotional stimulus. Researchers highlighted the role of prosody in emotional processes investigating the speech.

The ability to recognize emotion in speech is a critical skill for social communication. Human language relies on emotional cues that are defined by a number of non-verbal acoustic features, including pitch, timbre, tempo, loudness, and duration. Prosodic features such as fluctuations in vocal pitch and loudness have been linked to physiological responses associated with the emotion that is being expressed in both speech and music. According to arousal-based and multi-component theories of emotion, these physiological changes underlie emotion appraisal and physiological arousal may reflect one possible pathway by which vocal cues can convey information to a listener about a speaker’s internal state. During in-person interactions, vocal cues are closely coupled with changes in facial behavior reflecting the dynamic and multimodal nature of emotion cues during conversation. Relatedly, automatic mimicry of facial gestures occurs when processing emotional speech and singing and has been linked to emotion recognition In order to sing a specific pitch with one’s voice, a singer must be able to accurately associate a perceptual representation of the target pitch with the exact motor plan of the vocal system that would produce that pitch.

Singing is a vocal behavior that reflects sensorimotor processing. The ability to accurately vary vocal pitch is not only a critical feature in singing but also an important dimension for communicating spoken prosody, another vocal behavior relying on sensorimotor processing. Given that both singing and spoken prosody have been linked to individual differences in sensorimotor processing, it is possible that a similar mechanism that accounts for individual differences in vocal imitation of pitch in the context of singing may also account for individual differences in vocal emotion, as suggested by the Multi-Modal Imagery Association (MMIA) model , a general model of sensorimotor processing based on multi-modal imagery. Such a claim is supported by neuroimaging research that consistently demonstrates that motor planning regions are recruited during auditory imagery for both speech and music . A shared sensorimotor network for singing and vocal emotion aligns with predictions made by the OPERA hypothesis in which overlapping brain networks for music and speech are proposed to account for the facilitatory effects of music processing on speech processing. Sıngıng ıs a complex, dynamıc, multıdimensional behavior. The MMIA model is a general framework designed to account for the intersection of multiple modalities during mental imagery. The Opera hypothesis aims to explain why musical training would lead to adaptive plasticity in speech processing networks. According to this hypothesis, such plasticity is engaged since five essential conditions (overlap, precision, emotion, repetition and attention) are met by music processing. Extensive psychophysical research has shown that envelope is one of the majör contributors to a sound’s musical timbre.Behavioral studies support evidence for the role of vocal pitch perception in speech processing that involved in vocal production of speech and song shared same processes and have shown that inaccurate imitators of pitch in speech tend to also show impairments in imitating pitch in song.

Emotional prosody results from the dynamic variation of language’s acoustic non-verbal aspects that allow people to convey and recognize emotions. Emotional prosody can be defined as the ensemble of segmental and supra-segmental variations (referring to melodic aspects) of the speech production during an emotional experience, and it is conceived as an interface between language and affect. Emotional prosody categories have been described as correlating with a range of acoustic features which are essentially musical: rhythm, pitch, tone, amplitude, accent, pause, duration, and their unfolding. Each vocal emotion has its own acoustic profile, and the ability to decode emotions during social exchanges is not only crucial for developing social abilities, but is necessary for establishing fundamental affiliations in infancy and intimate relationships during development and in life. The vocal communication of emotions is thought to follow a model of dyadic processes, which are determinant for accurate encoding (or production) and decoding (or recognition) of vocal affects during social exchanges.

Prosodic features of vocal production play a fundamental role in decoding partners’ emotions and is a key index for assessing children, adolescents, and adults’ affective abilities. Basic recognition and knowledge of emotions develop early in life and grows throughout childhood and adolescence, improving our understanding, ability to manage, and adaptively utilize emotions in crucial periods of development.Visual and auditory sensory abilities play a crucial role in the early development of emotion recognition from faces and voices, respectively. Visual and auditory emotional information are related and both support early multimodal recognition of emotions as is the case in adults[https://www.nature.com/articles/s41598-022-21554-0](https://www.nature.com/articles/s41598-022-21554-0#ref-CR11). In the newborn period, facial recognition of an intimate partner is likely rooted in a prior experience with the mother’s voice, the latter being a highly salient and detectable signal even during pregnancy. During infant and child development, senses operate together to convey and to process emotional information, and the role of redundancy in cross-modal expression and perception of emotions is crucial for their emotional development.

Emotion recognition, especially in childhood and adolescence, is deeply linked with emotion regulation. Higher levels of emotion knowledge lead to better social skills in childhood and adolescence and, later in life, is a strong predictor of effective social behavior as well as early school and later academic success. Familiarity with the linguistic stimulus, not only involves semantic meaning processing, but constitutes an important factor contributing to the vocal processing of emotions. The maturation of the ability to recognize emotions from behavioral cues does not only manifest in an increased ability to recognize and experience emotions, but also in an improved capacity to perceive multiple emotions in a stimulus. In real life, people express emotions using acoustic characteristics pertaining to two or more basic emotions and the ability to detect emotions becomes more complex throughout development.

While children of 5–6 years of age tend to perceive and experience single, polarized emotions (e.g., good and bad as they grow up there is a tendency for emotional experiences to become more complex, mixed, or even contradictory. One of the indexes for evaluating emotion maturation is the increased ability to experience and to recognize multiple emotions in others.During childhood there is an evident tendency to feel and to attribute a single emotion. This tendency becomes gradually complex during development[https://www.nature.com/articles/s41598-022-21554-0](https://www.nature.com/articles/s41598-022-21554-0#ref-CR54). Children between 3 and 6 years of age demonstrate an initial capacity to both experience and understand mixed emotions[https://www.nature.com/articles/s41598-022-21554-0](https://www.nature.com/articles/s41598-022-21554-0#ref-CR55). This ability gradually develops, together with the ability to experience complex and possibly contradictory mixed emotions, as for example in the context of sarcasm or irony in complex social interactions.The differences between younger and older children in recognizing multiple emotions are mediated by developmental differences in empathy, the ability to experience others’ emotions. This complexification perspective, there is a continuity in the emotional development of children. Emotions are implicitly expressed in both facial expressions and prosodic components of vocal communication. The ability to recognize nonverbal cues of emotion is an important feature of social competence that matures gradually across childhood and adolescence.

In humans, competent social behaviour requires integration of multiple sources of information about interaction partners. While the intents, needs, and desires of other individuals are conveyed explicitly through verbal content, a complete understanding of the social environment requires an integration of literal text with other social indices such as the individual’s history, the context, and the nonverbal style in which the content is delivered. Others’ emotions and attitudes can be inferred from nonverbal cues, including facial expressions, body postures and gestures and the acoustic characteristics of the voice. The capacity to accurately interpret such information is thought to facilitate the selection of appropriate behaviours in social situations. The ability to recognize nonverbal cues of others’ emotions and attitudes, or emotion recognition (ER), has been linked to both social competence and psychological well-being in the general population. With many higher-order cognitive functions, emotion recognition (ER) is not fully mature at birth, but rather grows with age across childhood and adolescence. Learning to recognize nonverbal emotion cues is a critical developmental task for youth, as this skill is related to positive social outcomes across the lifespan. The use of singer’s own voice to produce music realize a mechanism of emotional induction in singer: singing requests the activation of several peripheral and autonomic processes inducing changes in internal state that could influence emotional state through a bottom-up mechanism. The induction of emotion through behavioural and peripheral changes has been reported for facial expression

Singing is a complex activity that involves both central and peripheral functions, such as mental processes and physical effort. A number of factors can affect the emotional experience related to performance. Emotional response is considered as a complex and multi-componential process involving several interacting systems, such as cognitive, motivational, expressive, behavioral, psychophysiological and subjective conscious experience. Compared to solo singing, singing in a group setting quickly leads to a sense of social connectedness Increases in well-being are also more pronounced when singing in a group. Results of a qualitative study with choral singers included an increase in experienced connectedness as well as physiological benefits (e.g., better breathing), cognitive stimulation, enjoyment, and transcendence. In elderly populations, singing has been associated with positive effects on pain, sleep quality, and dementia as well as better general health when active in amateur choirs (compared to professional choir singers . Well documented physiological effects of singing include the strengthening of respiratory muscles and the optimization of breathing, as well as an increase in the concentration of oxytocin and endorphins, which is considered indicative of improved immune defense and well-being. Similarly, a reduction in general physiological tension and an increase in heart rate have also been observed. An open-ended survey with a qualitative evaluation revealed positive effects on breathing and lung function, posture and body control, relaxation and stress, and energy level within a sample of choral singers. Emotional prosody is defined as suprasegmental and segmental changes in the human voice and related acoustic parameters that can inform the listener about the emotional state of the speaker.

Oral communication is critical for the human being, both through semantic meaning of words and non-verbal parameters. Voice prosody refers to changes in these acoustic parameters that complement the information or even add new information given by language and represents the so called melody of voice, which is related to pitch temporal variations, with other information such as spectral fluctuations related to timbre. Acoustic parameters (e.g. energy) are mainly shaped by the mechanisms of vocalization production, including mainly breathing, phonation and articulation which are themselves modulatde by emotion. Emotional prosody conveys information about the affective state of the speaker, and has a key role in the regulation of social interactions. According to the theories of embodied cognition, mental representations are constructed through the interaction of motor, sensoryn and affective systems. The body seems to intrinsically constrain and modulate the cognitive processes. Gesturing grounds people’s mental representations in action and Access to autobiographical memories is improved in a body position that is congruent between encoding and retireval. In the light of evolutionary processes, understanding other individuals and their intentions is crucial in social interactions. (477-487)

In the visual modality, three distinct mechansims have been observed: The first one is the visual analysis of facial parameters and dominant when decoding prototypical facial expressions. The second one is the conceptual analysis of the emotion taking into account available knowledge about the emitter and contextual information such as the social situation. The third one is teh embodied simulation defined as the process by which a facial expression triggers a simualtion of a state in the motor, somatosensory, affective and reward systems thatv represents the meaning of the expression of the perceiver. The perception of the body states in others produces a body mimicry in the observer. Facial mimicry reflects the sensorimotor simulation of an observed emotion rather than a simple muscular reproduction of an observed facial expression. According to the Simulation of Smiles model (SIMS model) the embodied simulation intervenes mainly when facial expressions are not prototypical and visual analysis of facial parameters is no longer sufficient but also when the individual is particularly interested in understanding the individual facing him/her. This model addresses processes related to facial recognition of emotion.

Emotion processing is a complex mechansim with multimodal sensory integration. Studies showed that individulas us etehir body and their senses as different sorces of information and they integrate them to communicate more effectively From an evolutionary perspective, it seems clear that the key decision of a perceiver (P) regarding a sender’s (S) smile is whether the smile is genuine or false (based on the Duchenne marker and postural, contextual, and experiential cues). Social relations vary in both the “horizontal” and “vertical” dimensions.The “horizontal” dimension describes the affective or socioemotional dimension, encompassing the valence of feelings and emotional closeness of interpersonal relations. Enjoyment and affiliative smiles, which communicate positive emotions and cooperative social motives, tend to occur when social relations are characterized horizontally. The “vertical” dimension, describes the fact that interpersonal relations can be organized along a low-to-high continuum of dominance, power, status, or hierarchy . Dominance smiles, which express status and control, facilitate social relations that take place in the vertical dimension of sociality. In this dimension, individuals seek to identify and/or establish their rank in a hierarchy rather than to build social bonds. As a result, eye contact tends to be suppressed, and complementarity of facial and postural expressions between dominant and non-dominant individuals is prevalent. These processes should render embodied simulation a less frequently used method for understanding a dominance smile.

Smiles are distinct and easily recognizable facial expressions that markedly differ in their meanings. Smile scan be classified based on three fundamental socail functions which tjey serve : expressing positive affect and rewarding self and others (reward smile ), creating and maintaining socail bonds (affiliative smile ) and negotiating socail status (dominance smiles).A smile can be simply described as a contraction of the *zygomaticus major* - a facial muscle which pulls the lip corners up toward the cheekbones “a muscle of joy.” This unique movement makes it an easily recognizable facial expression. Smiles can also be confusing in their meanings and functions they serve. Despite the association between smiles and positive feelings and intentions , trust and readiness to help, smiles can also be displayed during unpleasant experiences, i.e., to hide negative feelings, and be perceived as a signal of lower social status or intelligence . Smiling is used in a wide variety of situations, depending on the context and social norms learned through socialization and experience. Not only can the use of smiles and their social function vary considerably, but the very expression of a smile comes in many forms due to the contraction of the *zygomaticus major* muscle, the core feature of any smile expression – involves the activation of other facial muscles, creating a range of possible variations. [https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.00938/full](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.00938/full#B10) , for example, identified and described 18 types of smiles, differentiated in terms of their appearance and the situation in which they are likely to occur.

Despite its variability, the most commonly used smile typology is the distinction between ‘true’/genuine and ‘fake’/false smiles, with the former being sincere displays of joy and amusement, and the latter being produced voluntarily, possibly to increase others’ trust and cooperation. True and false smiles can be distinguished on the basis of their morphology: the presence of supposedly involuntary eye constriction ( the contraction of the *orbicularis oculi* muscle). People smile in many situations, involving diverse emotions or very little emotion Smiles can be classified in accordance to how they affect people’s behavior in the service of fundamental tasks of social living. This typology defines three physically distinct smiles of *reward*, *affiliation*, and *dominance*, which serve the main function of social communication and interaction. Reward smiles communicate positive emotions and sensory states such as happiness or amusement, thereby potentially rewarding both the sender and the perceiver. Affiliative smiles communicate positive social motives and are used to create and maintain social bonds. A person displaying an affiliative smile intends to be perceived as friendly and polite. Dominance smiles are used to impose and maintain higher social status. The person displaying this type of smile intends to be perceived as superior.

Research explored the physical appearance of reward, affiliative, and dominance smiles, including a description of the facial characteristics of each category, suggesting that the three functional smiles are indeed morphologically different. Given the multiple types of smiles, the diversity of situations in which they appear, and the varying display rules governing their production, the understanding of these facial expressions is a complex process which can rely on multiple mechanisms – such as a perceptual analysis of the expresser’s face, conceptual knowledge about the expresser and the situation, and sensorimotor involving the recreation of smile-related feelings and neural processes in the perceiver closely related to facial mimicry, which is defined as a spontaneous rapid imitation of other people’s expressions. As sensorimotor simulation involves a complex sequence of motor, neural, and affective. Facial mimicry, used to index sensorimotor simulation of emotion expressions, is sensitive to social and contextual factors. Its occurrence may depend on the type of expression observed, but also on the social motivation, attitudes toward the expresser and group status. Furthermore, it can be experimentally altered or restricted in laboratory settings using various pen-in-mouth procedures, stickers, chewing-gum, or sports mouthguards. In these cases, preventing mimicry responses has been shown to impair observers’ ability to accurately recognize happiness and disgust and discriminate between false and genuine smiles. (488-489)

During social interactions, speakers signal information about their emotional state through their voice, which is known as emotional prosody. The human voice is a critical social stimulus in a child’s environment. The voice not only conveys semantic information (“what”) through speech, but it also provides information about the identity (“who”) and the emotional state (“how”) of the speaker which is known as emotional prosody . Decoding these different pieces of information from the vocal signal is critical for navigating the social world. Understanding how a communication partner is feeling is crucial for providing empathy and support and is particularly important for building and maintaining interpersonal connections. Vocal-emotional information is conveyed by a speaker’s intonation, emphasis, rhythm, and speech rate , and these vocal gestures translate into an array of acoustical cues embedded in ongoing speech. For example, when a speaker is sad, vocal pitch and speech rate are reduced relative to neutral speech; however, when a speaker is happy, vocal pitch and speech rate typically increase compared to neutral speech. During the early stages of child development, young listeners begin to map these distinct acoustical features, which include changes in vocal pitch, timing, and timbre, on to speakers’ emotional states. Following extensive experience and learning, this vocal-emotional mapping yields an efficient auditory mechanism for rapidly ascertaining the emotional state of a communication partner.

The domains of music and speech are closely intertwined, as evidenced by similarities in the way they are structured and how they are processed by listeners. These similarities may help explain the association found between musical ability and vocal emotion recognition. Specifically, one similarity lies in hierarchical organization, whereby the higher units are defined by melodies in music and phrases in speech, while subordinate units are defined by the musical sounds and speech phonemes, both of which are processed through the same auditory pathways. Thus, the advantage in vocal emotion recognition found among musically proficient individuals may be explained by shared neural areas and operations for syntactic processing in music and language[https://www.nature.com/articles/s41598-024-66889-y](https://www.nature.com/articles/s41598-024-66889-y#ref-CR13).Musical training is associated with changes in cognitive and affective processing. Musicians exhibit different expressions of musical emotion and show stronger emotional experience in response to music. Musicians possess higher skills for the recognition of emotions expressed in music and they differ from non-musicians in the processing of the sadness and fear conveyed in music. However, the effects of musical training are not limited to the musical domain, and in particular certain aspects of speech processing have been shown to benefit from musical training. Musicians show improved performance in the encoding of speech sounds in detecting speech in noise in extracting rhythmical patterns in auditory sequences, and in processing pitch in speech. Moreover, musicians seem to possess advantages in processing speech prosody and extra-linguistic properties such as the emotional content of speech. The advantages musicians exhibit in both music and speech processing have been explained by enhanced acoustic skills that musicians acquire through continuous training. The transfer effect from musical training to speech processing is assumed to be due to acoustic and rhythmic similarities between the two functional domains.

In the communication of affect, music and speech share strong similarities, which has motivated the proposition of a shared “emotional protolanguage” of music and speech. In order to express emotions, both music and speech make use of the same or similar acoustic elements such as timbre or pitch. Similarities between music and speech are also observed in the temporal domain as musical and verbal expressions use “temporal windows” of a few seconds within which musical motives or speech utterances are represented.These strong associations between music and speech have also been observed on the neural level. Similarities have been found in brain networks active during processing of both music and language and it has been assumed that the communication of emotion in both domains may be based on the same neural systems associated with social cognition, including the medial superior frontal gyrus (SFG) and the anterior cingulate cortex (ACC).The network of brain areas involved in processing emotional prosody is assumed to mainly consist of the primary auditory cortices, the superior temporal gyrus (STG) and the inferior frontal gyrus, as well as subcortical regions including the amygdala and the hippocampus.Music training has been shown to alter the neural processing of music presumably based on functional and structural changes in the musician’s brain. Intense and continuing musical training leads to structural and functional changes of the brain that advance cognitive processes and increases sensitivity to acoustic features in music processing which may subsequently improve speech and specifically prosody processing.

Communication is made successful with the help of segmental (phonemes) as well as the suprasegmental (variations in intensity, frequency, and duration) features of the language that hold essential functions including different linguistic effects like lexical tone changes, question-statement contrasts, and change in emotions. Emotional prosody is one of the most basic functions of the suprasegmental features of the language . Through research, it is well accounted that the encoding of emotional states in speech is achieved by the variations in the global properties such as loudness, pitch, and speech rate. Most fundamental differences in auditory perception of emotions were found to be of anger and sadness, whereas surprise and disgust were the most difficult to perceive auditorily.Speech prosody is considered to be one of the most significant cues that help infants in acquiring their native language. During their interactions with infants, adults use infant-directed speech, which is loaded with exaggerated prosodic cues. Developing children have a heightened sensitivity to variations in the suprasegmental features and are quick in perceiving the emotion of the speaker. Infants start picking up the acoustic cues of stress, intonation, and rhythm, to understand the meaning of the utterance, much before starting to grasp and categorise the phonemes of their particular language. These features give the infants reliable cues in comprehending the speaker's communicative intent and the emotional state, which later plays an important role in the development of the social and language domains of the child. The emotionally loaded words evoked more significant sensory processing when compared to neutral words. There have been a variety of studies that pointed out that, the emotional content in speech has significant roles in facilitating attention, cognitive performance and, memory.

The three major categories of acoustic cues that shape the perception of emotions are speech prosody, voice quality, and vowel articulation . The auditory cues significant to emotion perception have been in descending order as fundamental frequency, duration, and intensity . The variability and mean of the fundamental frequency accounted for the perceived vocal pitch; and the differences in durations either at the sentence, word, or phrase levels accounted for the overall perceived duration. Further, the variability in intensity and mean intensity accounted for perceived vocal loudness. All of these components together determined the emotion of the perceived speech. When there is an emotional expression, even though voice pitch is the most dominant cue for prosody, other cues like the intensity and duration also change to inform the listener of the heightened emotion. Thus, even when there is a distortion in the perceived frequency cues, the listener will be able to perceive the emotion of the speaker accurately, using the other acoustic cues.When there is a sensory-auditory deficit, the perception of verbal signals becomes difficult along with the auditory prosodic cues. Difficulty in the perception of the emotional content of the information conveyed can develop a lack of awareness of the social situations and lead to deficits in social skills. Children with hearing impairment show delay in the acquisition of a broad range of language-mediated abilities when their performance on emotion identification task is poor. Congenital sensorineural hearing impairment, in the lower speech frequencies, there is higher residual hearing, and most of the emotional prosodic cues are of low-frequency content. For a more accurate perception of emotional content, the temporal fine-structure characters become a deficit in children with sensory neural hearing loss. The perception of the emotions is seen through 3 modes: auditory, visual and auditory-visual in children with hearing impairment, even though the overall performance is significantly lower, the auditory-visual mode could surpass the auditory-only or visual-only modes indicating that they rely on auditory cues for emotion perception. Singing as a group in an online amateur choir is a low-threshold, enjoyable, collaborative activity that has been shown to have a number of positive psycho-physiological effects.

As speech envelope coupling, music envelope coupling operates to synchronize brain oscillatory activity between music listeners. The frequency architecture of musical sound, the coupling with HRV and entrainment of brain oscillations to the structure of music operate to synchronize brain and body oscillations particularly for performing musicians.There are three basic conclusions,:brain and body oscillations form a single hierarchy, individually scaled, follow a mathematical/physical law. Brain and body oscillations are aligned to each other, their frequencies do not vary randomly or arbitrarily. Representing a single hierarchy, brain and body oscillations show identical coupling principles.This holds true for principles that govern coupling between brain and body oscillations. The most ubiquitous principle is phase amplitude coupling, which is the best documented coupling principle not only for brain oscillations but also for body oscillations. The rhythmic fluctuations in HRV, most strongly influenced from the respiratory system, represent a clear case of amplitude coupling, where the phase of a slower frequency (e.g., of BF) modulates the instantaneous period of HR. The binary hierarchy theory represents a strict definition of a single hierarchy to which brain and body oscillations belong. This means that if a single frequency is known (such as e.g., HR or alpha), all other frequencies are also known. The same conclusion can be drawn for musical sounds. If a single frequency of a musical sound is known (determined) then all others are ‘known’ . This property allows the prediction (knowledge) of all frequencies of the oscillatory hierarchy.

The brain and bodies of different individuals are different. As an example, resonance properties of limbs (which depend on their size), the hydrodynamics of the cardiovascular system (which depend on a variety of different factors, such as total blood volume and body mass) and of the brain (such as network size, and extent of myelination) are factors that ‘scale’ the frequencies. Each individual has his/her own frequency structure that depends on a variety of biological and neurophysiological properties. Brain and body oscillations obey mathematical and physical rules. This means that the body functions – including thinking – not only depend on biological ‘laws’, they also depend on laws that are rooted in mathematics/physics. (490-494)

Biological systems exhibit large fluctuations. They are considered to provide a ‘noisy environment’. Variations in instantaneous frequency or HRV are good examples. But this variability does not reflect noise, it reflects coupling principles between frequencies, which can be understood to reflect communication between brain and body oscillations. The oscillatory hierarchy may be considered a ‘default’ frequency architecture, to which frequencies preferentially shift in a task‐dependent manner. (495)

Variations in beat-to-beat interval evoked by rhythmic breathing that occurs during a respiratory cycle were described in the middle of the nineteenth century. During spontaneous breathing, the heart rate (HR) decelerates during expiration and accelerates during inspiration. It is a well known phenomena in physiology—respiratory sinus arrhythmia (RSA). When the breathing frequency slows down to 6 breaths/min, the amplitude of the heart rate variability (HRV) reaches its maximum. Consequently, a breathing frequency of 0.1 Hz is often referred to as a ‘resonance frequency’.Since ancient times, slow breathing has been believed to have a beneficial effects on mental relaxation through the enhancement of autonomic, cerebral and psychological flexibility. Decelerated breathing at 0.1 Hz promotes synchronisation between breathing, RSA and slow cortical potentials. Respiratory activity crucially regulates the flow of cerebrospinal fluid.

Respiratory sinus arrhythmia (RSA) is heart rate variability in synchrony with respiration, by which the R-R interval on an ECG is shortened during inspiration and prolonged during expiration. Although RSA has been used as an index of cardiac vagal function, it is also a physiologic phenomenon reflecting respiratory-circulatory interactions universally observed among vertebrates. Baroreceptor afferent information and other signals coupled with respiration and the heartbeat that may lead to reflex cardiac vagal outflow are not for the inhibition caused by inspiratory activity. The combination of the two factors, expiration driving interval prolongation and cardiac contractions driving inspiration creates a system in which the entrainment of the two rhythms, cardiac and respiratory, may ocur when timings align. During the inspiratory period , cardiac intervals are roughly 600 ms in duration, which is too short to allow an immediate vagal effect on teh ongoing beat when expiration n would open the gate. For this effect to ocur, intervals must exceed approximately 750-800 ms. If expiration begins with aerly in cardiac interval, the next heartbeat could already experience the full vagal effect.

Beat-to-beat heart rate variability is significantly related to respiration. The term RSA refers to the fact that, despite the “arrhythmia,” each heartbeat still originates from the normal pacemaker of the heart, the sinus node. Under vagal control, HR increases during inspiration and decreases during expiration. The deeper and slower the respiration, the larger the HR excursions. As BP-variations accompany these changes—decreasing during inspiration and increasing during expiration—a baroreflex origin of the vagal activity has been postulated. Even early in vertebrate evolution, there is a coupling between HR and respiration. RSA has been observed in fish, where water ingestion and gill movements take the place of inspiratory activity. They describe how changes in HR adapt the circulation to the moments of optimal gill perfusion when fresh water is pushed along the delicate membranes. This trait is evident throughout evolution, with inspiration favoring increases in HR and lung perfusion, optimizing the effects of the respiratory action. This increase in HR is not due to sympathetic activity but the suppression of cardiac vagal output.The variation of heart rate in phase with breathing, known as ‘respiratory sinus arrhythmia’ (RSA), is a physiological phenomenon present in all air-breathing vertebrates. RSA arises from the interaction of several physiological mechanisms but is primarily mediated by rhythmic changes in cardiac parasympathetic (vagal) activity, increasing heart rate during inspiration and decreasing heart rate during expiration. RSA amplitude is an indicator of autonomic and cardiac health; RSA is diminished or absent in common pathological conditions such as chronic heart failure and hypertension.

Slow breathing:

(1) increases the strength of the respiratory–cardiac coupling in the SAS and BP;

(2) augments the strength of the coupling between the respiratory component of the BP mode and the cardiac component of the SAS;

(3) enhances the strength of the coupling between the respiratory component of the SAS and cardiac component of the BP; and

(4) decreases the similarity of the coupling between the respiratory and cardiac components of the BP and SAS, between the respiratory component of the BP and cardiac component of the SAS and between the respiratory component of the SAS and the cardiac component of the BP. Respiratory resistance applied during slow breathing does not affect the coupling strength of the assessed functions, however it partially restores their similarity.

### The coupling functions for the SAS signals for both hemispheres have similar shapes. Intracranial pressure oscillations are associated with sympathetic activity in a reciprocal way to arterial baroreflex. Even a small increase in intracranial pressures augments sympathetic firing, with a subsequent BP elevation, which in turn promotes cerebral perfusion pressure stability over time. The SAS respiratory oscillation effects the BP cardiac accelerations and decelerations. Slow breathing enhances the strength of the coupling between the respiratory component of the SAS and the cardiac component of the BP). CSF movements resulting from bigger pressure gradients generated by respiratory movements lead to enhanced changes in sympathetic activity and corresponding changes in HR.The similarity of the coupling between all pairs of oscillators is diminished during slow breathing. By implementation of inspiratory resistance, this effect can be partially reversed. Slow breathing is associated with augmented lung volume, which results in Hering–Breuer reflex stimulation. The role of Hering–Breuer reflex, mediated by activation of stretch receptors, is lung protection from overinflation. All of these stimulate vagus afferents. Additional effort to inhale, during slow breathing with resistance, increases sympathetic activity. The BP-SAS amplitude coherence SAS  at cardiac frequency is stabilised by the sympathetic nervous system. Changes in autonomic nervous system activity less affected phase coherence.

Slow breathing synchronises the SAS oscillations between brain hemispheres and diminishes the similarity of the coupling between all analysed pairs of oscillators, but inspiratory resistance partially reverses this phenomenon. There are individual differences in resonance frequency that vary from 4.5 to 6.5 breaths per minute. Oscillations serve a critical role in organizing biological systems. In the brain, oscillatory coupling is a fundamental mechanism of communication. The possibility that neural oscillations interact directly with slower physiological rhythms (e.g., heart rate, respiration) is largely unexplored and may have important implications for psychological functioning. Oscillations in heart rate, an aspect of heart rate variability (HRV), show remarkably robust associations with psychological health. The act of controlling one’s breath for the purpose of restoring or enhancing one’s health has been practiced for thousands of years amongst Eastern cultures. For example, yogic breathing (pranayama) is a well-known ancient practice of controlled breathing, performed in conjunction with meditation or yoga, for its spiritual and perceived health-enhancing effects. Various forms of pranayama exist, such as nostril breathing (double, single or alternate), abdominal breathing, forceful breathing and vocalised (chanting) breathing, which are performed at varying rates and depths [

The term “tidal breathing” defines normal respiration with a relatively constant rate and inspiratory/expiratory volumes (tidal volume). Tidal breathing is driven by a group of primary and accessory inspiratory muscles collectively named the “respiratory pump”. The major respiratory muscle is the diaphragm, which, during normal inspiration, contracts and flattens, pushing on the abdomen, while the lower ribs are pushed upwards and outwards. Coordinated contraction of the diaphragm, external intercostals, parasternal, sternomastoid and scalene muscles results in expansion of the ribcage and rising of the chest. This generates a transdiaphragmatic pressure (increased abdominal pressure and decreased thoracic pressure) resulting in a decrease in intrathoracic/intrapleural pressure and subsequent ventilation of the lungs upon which pulmonary gas exchange occurs *via* the alveoli across the transpulmonary pressure gradient. Expiration is generally passive, with the diaphragm returning to its domed resting configuration, causing the lungs to deflate and expel air. When breathing effort is increased, however, the expiratory muscles become active; these include abdominal muscles which pull the abdominal wall inwards when contracted, forcing the diaphragm to rise superiorly into the ribcage and deflate the lungs.Studies of diaphragm movement and function claim that optimal respiration requires active control of the diaphragm, such that during inspiration, the lower ribs stay low and only expand laterally, while the abdomen expands instead of the chest. Analysis of diaphragm movement during tidal breathing and breath holding using magnetic resonance imaging (MRI) and spirometry has reported a correlation between the degree of movement of the diaphragm and changes in lung volume: the greater the difference in diaphragm movement between inspiration and expiration, the greater the tidal volume. Diaphragmatic breathing has also been shown to facilitate slow respiration.

The biomechanics of lung ventilation are carefully coordinated with blood oxygen, carbon dioxide and pH homeostasis. Minute ventilation is defined as respiratory rate multiplied by tidal volume; thus, to maintain minute ventilation, if respiratory rate is decreased, tidal volume must be increased. A decrease in respiratory rate alone would lead to hypercapnia and activation of chemoreceptors (predominantly central chemoreceptors located in the brain stem) that respond primarily by orchestrating a forced increase in respiration rate (hyperventilation) . Therefore, in order to maintain a decreased respiratory rate without disturbing respiratory homeostasis, tidal volume must be increased. It has been shown that controlled slow respiration at 6 breaths per min in healthy humans reduces the chemoreflex response to hypercapnia and hypoxia, compared with spontaneous respiration or controlled respiration at 15 breaths per min. Physiological dead space is the sum of anatomical dead space (air that does not reach the alveoli) and alveolar dead space (air that enters poorly or nonperfused alveoli); increasing respiratory rate does not improve ventilation efficiency because dead space is increased. Decreasing respiratory rate and increasing tidal volume has been shown to improve ventilation efficiency *via* alveolar recruitment and distension, thus reducing alveolar dead space. Slow respiration at 6 breaths per min was found to be optimal for improving alveolar ventilation and reducing dead space in both groups in terms of increased arterial oxygen saturation and ease and sustainability in terms of respiratory effort. Follow-up of patients with chronic heart failure who practiced slow breathing displayed increased exercise performance and motivation.

The pumping of the heart and the flow of blood through the circulation are heavily influenced by various factors and events, such as oxygen demand, physical activity, stress, temperature and respiration . In a steady-state system, the effects that respiration has on the cardiovascular system may first be discussed in terms of haemodynamics. During normal inspiration, the pressure gradient between the right heart and the systemic circulation is increased due to the decrease in intrathoracic/intrapleural pressure being transferred to the right atrium, which results in an increase in venous return, filling of the right atrium and right ventricular stroke volume. Pulmonary resistance increases, pulmonary venous return is decreased and blood pools in the pulmonary capillaries, leading to a reduction in filling of the left heart . This increased storage of blood in the right heart and pulmonary circulation leads to an increase in cardiac output that occurs during the next intrinsic heartbeat. During expiration, these changes are reversed. These respiratory phase-driven fluctuations in venous filling, stroke volume, cardiac output and peripheral blood flow contribute to fluctuations in heart rate and blood pressure. Under steady-state conditions, increased venous return during inspiration equals increased cardiac output and an increased heart rate, which would also affect arterial blood pressure. The heart rate increases during inspiration while arterial blood pressure decreases, and *vice versa* during expiration.

While changes in the cardiovascular system can induce changes in respiration, the influence that respiration has on the cardiovascular system is reportedly stronger. Studies in healthy humans have found that controlled slow breathing, particularly at 6 breaths per min, is associated with an increase in fluctuations of both blood pressure and heart rate, compared to breathing at a typical rate and a tendency for heartbeats to cluster within the inspiratory phase. Relationships between heart rate, blood pressure and respiration are known as cardiorespiratory coupling.The instantaneous heart rate can be measured on an ECG recording as the time between beats: the R–R interval. Fluctuation of R–R intervals is a physiological occurrence known as heart rate variability (HRV). HRV and blood pressure fluctuations occur both randomly and rhythmically. Power spectral analysis of these fluctuations shows two significantly correlated rhythmic oscillations indicated by a peak at a frequency around 0.25 Hz (high frequency (HF)) and another at around 0.1 Hz (low frequency (LF)). The HF oscillations coincide with the typical respiration frequency (*i.e*. 15 breaths per min, 0.25 Hz) and are related to the phasic effects of tidal respiration on the cardiovascular system (mechanical, haemodynamic and cardiorespiratory mechanisms), whereas LF oscillations correspond to cardiac feedback mechanisms that are slower than and independent of respiration.

The baroreceptor reflex (baroreflex) is a negative feedback mechanism involving stretch receptors, present primarily in the aortic arch and carotid sinuses, that monitor arterial blood pressure and respond to acute changes *via* central–neural–autonomic pathways. Arterial baroreceptors are activated by an increase in blood pressure and fire signals *via* afferent nerves to the cardiovascular centre in the medulla oblongata, which relays fast parasympathetic efferent signals *via* the vagus nerve to the sinoatrial (SA) node to decrease heart rate, while sympathetic efferent signals relayed *via* the sympathetic chain in the thoracic spinal column to the heart and blood vessels are suppressed, adding to decreased heart rate, cardiac output and vasomotor tone. Baroreceptor activity is reduced when blood pressure is low, resulting in the reverse effects. LF oscillations of arterial blood pressure (known as Mayer waves) are thought to represent the sympathetic arm of the baroreflex, which oscillates slower than respiration at 0.1 Hz. The baroreflex is therefore tightly coupled to LF HRV oscillations.

HF HRV and baroreflex activity are influenced by the phasic effects of respiration, with the rate of respiration modulating the relationship between the HRV and blood pressure oscillations. It has been indicated that slow breathing causes the pulse harmonics of blood flow (*i.e*. blood pressure oscillations) to synchronise with the rhythm of the heart. Various studies have found that slow breathing increases amplitudes of blood pressure oscillations and HRV, and that this is particularly significant at a respiration rate of 6 breaths per min (0.1 Hz). At 6 breaths per min, the LF HRV oscillations are said to be augmented by respiration. Studies on the effects of respiratory phase time ratio have reported a tendency for baroreflex sensitivity and HRV amplitude to increase when the inspiration/expiration ratio is 1/1 during slow breathing at 0.1 Hz. The rhythmic influence of phasic respiration on HRV is a physiological phenomenon known as respiratory sinus arrhythmia.

Respiratory sinus arrhythmia (RSA) is HRV in synchrony with the phases of respiration, whereby R–R intervals are shortened during inspiration and lengthened during expiration. RSA has a frequency of 0.25 Hz (*i.e*. respiratory frequency) as reflected in the HF HRV oscillation peak. RSA frequency therefore changes with respiration rate to result in a shift in the phase difference between respiration and HRV (the heart rate response) and a change in the amplitude of HRV. Maximisation of RSA/HRV at around 6 breaths per min has been confirmed by numerous studies. This indicates cardiorespiratory system resonance and is hence referred to as a “resonant frequency effect” . At 0.1 Hz, RSA also resonates with the LF baroreflex integration frequency and Mayer waves. Both HRV (RSA) and baroreflex sensitivity are maximised when respiration is slowed to ∼6 breaths per min though this resonant frequency does vary between individuals. Increasing tidal volume and diaphragmatic breathing have been shown to significantly increase RSA, significantly more so at slower respiration rates. Numerous studies have reported decreased RSA with increasing respiration rate.

Two arms of the autonomic nervous system exert opposing control over the heart. Cardiac parasympathetic efferents are relayed *via* the vagus nerve and induce cardiac slowing *via* acetylcholine release, while sympathetic efferents are relayed *via* a network of nerves within the sympathetic chain of the thoracic spinal column and accelerate the heart rate *via* norepinephrine release. Both systems display an intrinsic, tonic rhythm that is generated by a central neural mechanism. Vagal activity is capable of eliciting a much faster influence on the heart than sympathetic activity, presumably due to faster signal transduction and acetylcholine-receptor kinetics, capable of delaying the immediate heartbeat to modulate the heart rate at higher frequencies, while cardiac sympathetic influence drops off at ∼0.1 Hz. Acetylcholine inhibits noradrenaline release and overshadows noradrenaline at the SA node. Parasympathetic activity is said to be the dominant arm of the autonomic nervous system, providing a homeostatic background level of control over the heart rate under resting conditions. Sympathetic activity is minimal or absent under resting conditions in healthy humans, whereas it is high in various disease states, and in healthy humans during exercise, and physical and mental perturbation .Both arms of the autonomic nervous system are under the control of the central respiratory centres, where autonomic drive from the reflex mechanisms and the lung stretch receptors converges. Autonomic outflows are inhibited during inspiration and disinhibited during expiration: the respiratory gate theory. The observed correlation between phasic parasympathetic vagal activity (“vagal tone”) with respiratory phase-related HRV oscillations underpins the hypothesis that RSA is largely a vagal phenomenon

Respiratory activity phasically alters membrane potentials of preganglionic vagal and sympathetic motoneurones and continuously modulates their responsiveness to stimulatory inputs. The most obvious manifestation of this ‘respiratory gating’ is respiratory sinus arrhythmia, the rhythmic fluctuations of electrocardiographic R–R intervals observed in healthy resting humans. Phasic autonomic motoneurone firing, reflecting the throughput of the system, depends on the intensity of stimulatory inputs. When levels of stimulation are low (as with high arterial pressure and sympathetic activity, or low arterial pressure and vagal activity), respiratory fluctuations of sympathetic or vagal firing are low. The respiratory gate has a finite capacity, and high levels of stimulation override the ability of respiration to gate autonomic responsiveness. Autonomic throughput also depends on other factors, including the frequency of breathing, the rate at which the gate opens and closes. Respiratory sinus arrhythmia is small at rapid, and large at slow breathing rates. The strong correlation between systolic pressure and R–R intervals at respiratory frequencies reflects the influence of respiration on these two measures, rather than arterial baroreflex physiology. A wide range of evidence suggests that respiratory activity gates the timing of autonomic motoneurone firing, but does not influence its tonic level.

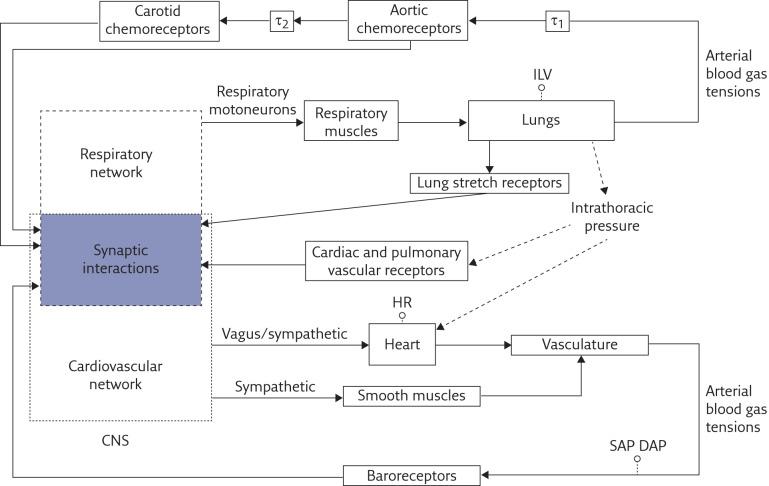


Fig. 79. Simplified model of cardiorespiratory control showing coupling between respiratory and cardiovascular systems. τ: circulatory delay; ILV: instantaneous lung volume; HR: heart rate; CNS: central nervous system; SAP: systolic arterial pressure; DAP: diastolic arterial pressure.

Breathing is linked with mental functions. In the millenary eastern tradition, tha act of breathing is an essential aspect of mediatative practices as a crucial factor for reaching the meditative state of conscioussness or Samadhi (Patanjali, Yoga Sutras). The breath is called Prana which means both breath and energy (the conscious field that permeates the whole universe. Prana-Yama (literally the stop/control, also rising/expansion of breath) is a set of greathing techniques that aim at directly and consciously regulating one or more parameters of respiration (e.g. frequency, deepness, inspiration/expiration ratio). In western culture, breathing techniques have been developed and used independently from any religious or spiritual belief or purpose for therapeutic aims (e.g. biofeedback, progressive realxation, autogenic training) and they are referred as paced breathing, based on slowing down the breath frequency and associated with relaxation and well-being, while fast breathing has been mutually linked to anxiety and stress. Slow breathing techniques (related both to slow paced breathing and HRV biofeedback) interact with cardio-respiratory system by increasing HRV and RSA, with a strong involvement of the parasympathteic system. Considering the centarlm nervous system, slow breathing techniques are paralleled by increases of alpha and decreases of theta power. The modulation of central nervous system activity by slow breathing techniques result in increase of EEG alpha power and decrease of EEG theta power associated with positive outcomes, improving vigor activity and reducing anxiety, depression, anger and confusion when considering psychological /behavior outcomes.The shift toward a parasympathetic predominance is conveyed to the central nervous system via the Nucleus of the Tractus Solitarius, which sends its projection to the thalamus and limbic system via the parabrachial nucleus. Slow breathing techniques are necessarily driven by brain top-down processes stemming from the voluntary shift of attention toward breath monitoring aiming at the active control of breathing rhythm. Mind-body therapies (i.e., techniques focusing on functional links between mind and body) such as slow breathing techniques, suggested the existence of an executive homeostatic network including the anterior cingulate, the prefrontal and the insular cortices, areas involved in physiological self-awareness and cognitive modulation.

A neurophysiological framework explaining the link between slow breathing techniques and conscioussness is realted to the fine tuning of thalamic and cortical activities exerted by the olfactory bulb. The neural patterns of this structure are modulated by the mechanical stimulation of the olfactory epithelium during nostril breathing, which is a fundamental aspect of every form of meditation. Nasal breathing is able to modulate both the autonomic system and brain activity through receptors located in the superior nasal meatus, which are sensitive both to mechanical and chemical stimuli. Studies both on animal mosdels and humans found a direct relationship between nasal stimulation and brain activity, independent from thoracic respiratory activity abolished by anesthesia of the nasal mucosa.Other studies demonstrated the presence of significant oscilaltions at the same freequency of the respiratory rate in a number of brain cortical and subcortical areas, (including the olfactory bulb, the pririform, somatosensory and prefrontal cortex and the hippocampus) which disappeared after tracheotomy and restored independently from thoracic respiration by the rhythmic delivery of air-puffs into the nasal cavity. The modulating effect of nostril breathing on the activity of the piriformcortex, amygdala and hippocampus has been unambiguosly demonstarted in humans.

Slow breathing reduces stress. Various clinical applications of slow breathing include treatment of stress-related disorders (anxiety, depression, acute or chronic pain), cardiovascular diseases (hypertension, heart failure), and [pulmonary diseases](https://www.sciencedirect.com/topics/medicine-and-dentistry/silo-fillers-disease) (asthma, chronic obstructive lung disease)[https://www.sciencedirect.com/science/article/pii/S0965229923000249](https://www.sciencedirect.com/science/article/pii/S0965229923000249#bib7) . Slow breathing is an integral part of many mind-body practices including yoga, t’ai chi, qi gong, meditation techniques (Zen, [Transcendental Meditation](https://www.sciencedirect.com/topics/nursing-and-health-professions/transcendental-meditation), Vipassana), and other relaxation techniques (relaxation response, biofeedback). Yoga, a common and ancient mind-body practice, has specific slow breathing techniques called [*pranayama*](https://www.sciencedirect.com/topics/nursing-and-health-professions/pranayama). Slow breathing has been defined as a respiratory rate less than 10 breaths a minute . Breathing at slow rates reduces psychological stress as measured by self-report. The reduction in psychological stress have been attributed to slow breathing rhythms entraining [neuronal activity](https://www.sciencedirect.com/topics/psychology/neuronal-activity) in networks that affect emotion, cognition, and memory[https://www.sciencedirect.com/science/article/pii/S0965229923000249](https://www.sciencedirect.com/science/article/pii/S0965229923000249#bib13). Slow breathing has been reported to reduce physiological stress as measured by changes in the autonomic nervous system with a decrease in sympathetic and increase [parasympathetic tone](https://www.sciencedirect.com/topics/medicine-and-dentistry/parasympathetic-tone).

Respiratory rhythms exert substantive influences on perception, emotion, and cognition[https://www.nature.com/articles/s41598-025-92017-5](https://www.nature.com/articles/s41598-025-92017-5#ref-CR9). Breathing is an integral component of interoceptive processing, that is, the state of the physiological condition of the body[https://www.nature.com/articles/s41598-025-92017-5](https://www.nature.com/articles/s41598-025-92017-5#ref-CR10). Respiration is unique compared with other systems (e.g. gastrointestinal) as conscious regulation can immediately impact respiratory processes. Instructed breathing patterns are applied to treat a variety of complaints and conditions, e.g., pain, stress, post-traumatic stress disorder. These patterns involve a voluntary reduction of breathing frequency, which is assumed to increase parasympathetic activity. Slow breathing at 4.5 to 6.5 breaths per minute (coherent or resonance breathing) has been shown to optimally balance sympatho-vagal stress response for most adults. Heart rate variability(HRV), the beat-to-beat variation in either heart rate or the duration of the R-R interval–the period, a clinical and investigational tool, is an index of cardiac autonomic activation as well as an outcome variable in breathing training or HRV biofeedback research

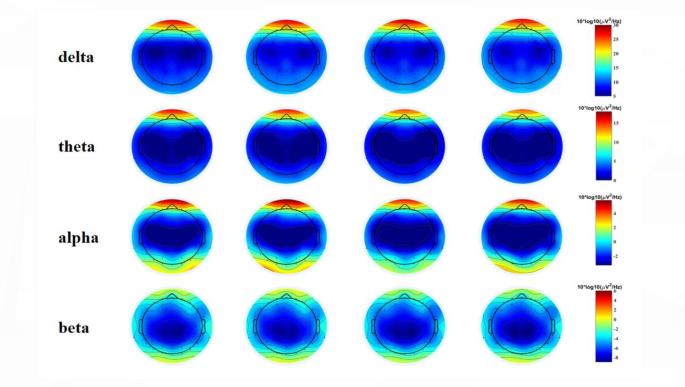


Fig. 80. Spatial distribution map of anticipatory phase in each frequency band; The first column shows the uncertain condition of fast breathing, and the second column shows the certain condition of fast breathing. The third column is the uncertain condition of slow breathing, and the fourth column is the certain condition of slow breathing.

Respiratory rhythm is one of the main oscillating rhythms of the body, which is the main source of interoceptive information for the brain. Anxiety is a disease of physical and mental interaction, which is characterized by excessive worry about uncertain events in the future and disturbance of autonomic nervous system. A higher HRV is an indicator of adequate adaptation to the new environment and effective functioning of the autonomic nervous system (ANS). The escalation in the heart rate is due to increased sympathetic and decreased parasympathetic activity. A significant improvement in HRV may be due to an increase in parasympathetic activity or a decrease in sympathetic activity. These factors indirectly contribute to reducing psychological parameters such as distress, anxiety, and depression in young healthy subjects. The brain and body operate together through the integrated activity of the central and autonomic nervous systems (CNS and ANS, respectively). High-frequency HRV (HF-HRV), which reflects 0.15-to-0.4-Hz cyclical fluctuations in heart rate associated with respiration, provides an index of the parasympathetic contribution to cardiac activity and is predominantly mediated through the vagus nerve. Higher HRV is associated with better emotion regulation, executive functioning ability to cope with stress , and overall mental well-being. HRV biofeedback, in which participants learn to increase HRV through real-time feedback and breathing techniques, has been reliably found to improve cognitive function and emotion regulation . These findings suggest a directional pathway between HRV and CNS function. Slower physiological oscillations can regulate cortical excitability and serve a role in coordinating the synchronized rhythmic activity of neural assemblies for efficient neural communication and cognitive function. (496-503)

### It is found that taller people had slower resonance frequencies than shorter people and assumed that greater blood volume is associated with greater inertia in the blood supply, and a greater delay in the baroreceptor loop. The psychological aspect is characterized by positive emotions, reduced stress, and is associated with the appearance of very rhythmic (sinusoidal) waveforms of HRV at around 0.1 Hz. Biofeedback with the aim to enhance 0.1 Hz HRV and induce relaxation . 0.1 Hz waves do not belong to the binary hierarchy. The tight coupling between three 0.1 Hz waves (BF, HRV and BP) and the 1 : 10 ratio with HR, implies a decoupling from the binary hierarchy. Since the binary hierarchy reflects a system for optimal coupling between the brain and body oscillation, resonance breathing may be considered a situation, where body oscillations are entrained to the resonance properties of the cardiorespiratory system, but are only weakly coupled with brain oscillations. The movement of the two legs during walking is the most prominent example of body part oscillations. It can be described in terms of coupled oscillators

### Sleep EEG is a good example for state-dependent frequency changes. Alpha slows down and disappears as dominant oscillation before the onset of sleep. After sleep onset (except REM sleep), two brain oscillations are dominant, slow oscillations (SO) of about 0.75 or 0.8 Hz and spindle oscillations with a mean spindle frequency (SF) of about 13 . Amplitude coupling plays an important role during sleep, in human subjects. Amplitude coupling between SO, SF, and ripples in hippocampus, is associated with memory consolidation.

### The sound plays a vital role for inducing emotional feelings and communication via music. Psychophysiological studies on singing show that song structure, breathing and HRV are coupled. The song structure determines the time windows for breathing (i.e., for inhaling and exhaling) and drives HRV. The hearts of singers become synchronized, they accelerate and decelerate at the same time. In completely analogous way as speech envelope coupling, music envelope coupling operates to synchronize brain oscillatory activity between music listeners. All of these factors, the frequency architecture of musical sound, the coupling with HRV and entrainment of brain oscillations to the structure of music operate to synchronize brain and body oscillations particularly for performing musicians.

### Brain and body oscillations are aligned to each other. The phase amplitude coupling, is the best documented coupling principle not only for brain oscillations but also for body oscillations. The rhythmic fluctuations in HRV, most strongly influenced from the respiratory system, represent a clear case of amplitude coupling, where the phase of a slower frequency (e.g., of BF) modulates the instantaneous period of HR. The binary hierarchy theory represents a strict definition of a single hierarchy to which brain and body oscillations belong. This means that if a single frequency is known (such as e.g., HR or alpha), all other frequencies are also known as well as if a single frequency of a musical sound is known (determined) then all others are ‘known’ . This property allows the prediction (knowledge) of all frequencies of the oscillatory hierarchy. The brains and bodies of different individuals are different. As an example, resonance properties of limbs (which depend on their size), the hydrodynamics of the cardiovascular system (which depend on a variety of different factors, such as total blood volume and body mass) and of the brain (such as network size, and extent of myelination) are factors that ‘scale’ the frequencies. This means that each individual has his/her own frequency structure that depends on a variety of biological and neurophysiological properties. Biological systems exhibit large fluctuations that reflect coupling principles between frequencies, to communicate between brain and body oscillations.

### The oscillatory hierarchy may be considered a ‘default’ frequency architecture, to which frequencies preferentially shift in a task-dependent manner. Phase locking establishes coherent oscillation among atoms in order to facilitate long-range interactions and energy storage as the key principle of energy resonance and information transfer in humans. In quantum field theory, phase locking facilitates order, coherence and collective modes of communication as an internal antenna that enables a person to exhibit self-awareness and coordination. The electrical activity of neurons oscillating simultaneously at the same frequency in separate parts of the brain is an example of phase locking. The principle of phase locking has demonstrated the role of neural synchronicities as a mechanism for neural integration of cognitive tasks. Neural oscillations, that provide a powerful means to encode and transfer information in space and time, are the most efficient mechanism to transfer such information reciprocally between neural assemblies .They exist at multiple spatial levels from microscopic to macroscopic which can arise from mechanisms within individual neurons as well as interactions between them , all of which are a component of the bioelectric structure.

The brainwaves observed on EEG are in fact mesoscopic or macroscopic oscillations. Subthreshold membrane potentials, that are a major microscopic component of the layers that occur in frequencies observed in an EEG, serve as a means of information representation, computation, and transmission, with various types and patterns of synaptic connections and potential oscillations and provide a means for individual neurons to be a part of a collective whole . Such intrinsic single cell oscillations form the basis for frequencies of mesoscopic activity generated by the summed dendritic activity of many neurons within a neural assembly which can be viewed in an EEG . Neuronal assemblies can synchronize with other adjacent or distant assemblies to form stronger and more global macroscopic oscillations responsible for the greater neural electromagnetic field . The emergent characteristic of large-scale bioelectric activity provides a metastable bridge to global coherence needed for an integrated experience.

Brains are systems that never reach a truly steady-state, constantly changing in dynamic patterns . A concept of nonlinear dynamics, metastability in regards to the brain describes the local-global harmony of the brain which may be responsible for the emergence of consciousness; distinct functional modules coupled together *via* neural oscillations while still maintaining their intrinsic, independent behavior. There is a competition in brain regions between the tendency to act autonomously and to cooperate macroscopically with other regions. In this metastable mode of functioning, although there is competition between the stability of either tendency, these local and global tendencies can coexist . Oscillations may be an optimal metastable mechanism as they provide a low-energy operation for local and distant communication which is lost in action potential signaling in distant axonal connections. A relatively large brain with only axonal connections would have severe spatial and metabolic constraints .

The Default Space Theory has been proposed as a unified theory of consciousness that includes the brain and body in describing the infrastructure of consciousness, and posits the brain and body together form the foundation of conscious experience that exists as a three dimensional internally generated simulation of reality termed the 3D dynamic default space, which is maintained and formed from all the cells of the body . Current neuroscientific views focus mainly on information, behavioral, affective, or cognitive features of brain and consciousness, e.g. Information Integration Theory/IIT , or cognitive, e.g. Global Neuronal Workspace Theory/GNWS or Predictive Coding .

The brain’s “intrinsic” time concerns the “duration” of neuronal activity embedded in specific frequency ranges, that are distinguished from higher frequency ranges like ultrasound or lower frequency ranges of other nature phenomena such as seismic earth waves. The brain’s “intrinsic” time and space or its “operational time and space” can be characterized by “temporal duration” and “spatial extension” of its neural activity. The brain shows an extensive structural connectivity that links across neurons, regions and networks and provides a “hardware”, though which the neurons could functional communicate (e.g. functional connectivity). Although there is strong dependency of functional connectivity on structural connectivity , the divergence between them is consciousness relevant . The brain’s “intrinsic” space is also related with its small-world organization (e.g. spatially scale-free) with various features including modularity, centrality and so on.

Reflexes are an automatic first line defense against major and minor impending dangers. Sensory information utilized by unconscious reflexes undergoes a different route of processing than being integrated into conscioussness percolated throughout the thalamo-cortical system. Reflexes operate at significantly faster speeds than the half second delay required for sensory information to enter conscioussness. For example, in the auditory system, auditory signals entering conscioussness make their way through the brainstem and thalamus up to the auditory and prefrontal cortex for advanced auditory cognition. When utilized inreflexes, acoustic information is processed in the caudal pontine reticular nucleus of the brainstem and modulated by the limbic system including the amygdala, hippocampus and stria terminalis.

A body-wide bioelectric architecture satisfies the requirement of global binding coherence for a coalesced conscioussness, synchronizing local computations in widespread symphony. The oscilaltory symphony of conscioussness is mediated by the interconnectedness of several regions in the brain with each region playing unique role in its formation. The thalamus along with areas of brainstem act as the conductor of this symphony, orchestrating many regions of the brain. Syndromes like contralateral neglect and phantom limb syndromes point to the existence of a continously maintained neural representation of the environment and self taht spans the conscious and unconscious mind. Disruptions to neural circuits that maintain thsi representation, whether through injury or deafferentation(loss of sensory input) can lead to distortions or even hallucinations nin the perception of the World.

Individuals navigate in a fast changing environment, so defensive responses must adjust rapidly as a function of the predicted spatial position and natüre of external threats. Reflexes process utilize and initiate responses to sensory information before it enters conscious awareness. The fastest human reflex, the blink reflex takes around 20 ms and slower reflexes utilizing the legs respond in about 150 ms. Reflex mechanisms utilize complex multimodal sensory and cognitive information(e.g.indicating the location and type of potential threat) in producing an appropriate response, for instance, information. For this sort of speed to occur in defensive reflexes with such a sensory and cognitively mediated action, the unconscious neural processes underlying reflexes must be integrated or united with cognitive simulation of the environment which defines our phenomenal mind. This would bypass a need for separate time-consuming computation on vast amounts of afferent sensory data to determine any potential reflexive needs given dangers in the environment.

Spatial information and other aspects of potential threats are utilized in producing a defensive reflexive response. There is a defensive peripersonal space (DPPS), surrounding the face with a protective cognitive attention. . Potential threats occurring within this space elicit stronger defensive responses compared to those located outside of it. Neural processes underlying startle reflexes link exploit predictions on the spatial location of threatening stimuli in a deliberate and purposeful manner with both the current and future predicted positions of the potential threat in respect to the body being accounted for. The environmental information about potential threats are exploited via top-down modulation from the cortex to the brainstem. This top-down modulation is continuously and purposefully administered. Its nature is determined by a number of additional high-level cognitive factors.

Attention unconsciously generated by reflexive processes acts as a filter, directing our focus on specific aspects of the sensory environment. The integration of reflexes with the conscious mind is evident through priming (unconscious reflexes influencing what captures conscious attention), habituation (repeated stimuli triggering a decrease in the reflex response that conscious attention can override), and voluntary control (exerting conscious control over reflexes in some cases) .The integration of lower brainstem reflexive processes with higher-order is bidirectional interface in influence between the contents and structure of the phenomenal mind and the coordinated actions of reflexes suggests the existence of a global cognitive architecture isomorphic to the phenomenal representation of the self and environment. According to the Default Space Theory of Consciousness and other prominent theories on consciousness, consciousness is an emergent phenomenon which arises as the virtual recreation or simulation of the environment and the individual’s relationship to it

The default space is always active in a conscious person and exists in an idling

state even without sensory input [6]. This idling state is maintained by baseline

neural oscillatory activity from salient networks such as the default mode net-

work and brainstem [8]. The oscillations occur throughout the entire body and

are dominated by the alpha, beta, and gamma frequencies, however, range from

slow to ultrafast [14]. These self-sustaining oscillations of feedforward and feed-

back information synchronize the sensory organs and cortical counterparts [4].

The synchronized information is filled into the intra-personal space; therefore,

the brain and body function together in a unified fashion [2]. This global dy-

namic network between the central and peripheral nervous systems: 1) is highly

organized, 2) includes the transmission of very specific electrical and chemical

signals that are self-perceived internally, and 3) replicates the external and in-

ternal world [4].

Although the external world is recreated internally, this replication is not a

sole result of exteroceptive and interoceptive sensory stimuli. The final simula-

tion of the external world is heavily influenced by attention, memory, and other

executive functions [6]. The thalamus plays an important role in the selective at-

tention of sensory information [15], and thalamic injury can lead to severe at-

tentional deficits [16]. Due to the thalamus being the central hub in coordinating

sensory integration into the default space, attention to certain sensation mod-

ulates what information is integrated into consciousness [6]. Thalamocortical

oscillations adaptively resonate with sensory organs in a format organized by the

thalamus so that those sensory organs selectively paid attention to rise to aware-

ness [6]. This attentional gating occurs through the thalamic reticular nucleus

[17] [18], directing attention via an internal attentional “searchlight” [19].

Through inhibiting or disinhibiting certain thalamic relay cells, the thalamic re-

ticular nucleus may control which sensory organs are synchronized with the

cortex [18].

Comatose states are characterized by an absence of arousal and consciousness.

Through studying what happens when consciousness is absent, we can better

understand what leads to it. The important role of the thalamus in consciousness

is demonstrated in the development of coma after thalamic lesion [20]. Thalamic

stimulation has been shown to be a possible treatment for comatose states

through case studies of resulting responsive behavior [21] [22]. Recently,

non-invasive ultrasound pulsation techniques have proven successful in stimu-

lating the thalamus leading to substantial improvement of patients along the

Coma Recovery Scale [23]. This effect is believed to act via modulation of tha-

lamocortical communication [24] and has been shown to speed anesthetic re-

covery in animal models [25]. During anesthetized states, there is reduced corti-

cothalamic connectivity [26] and thalamic metabolism and blood flow are re-

duced [27].

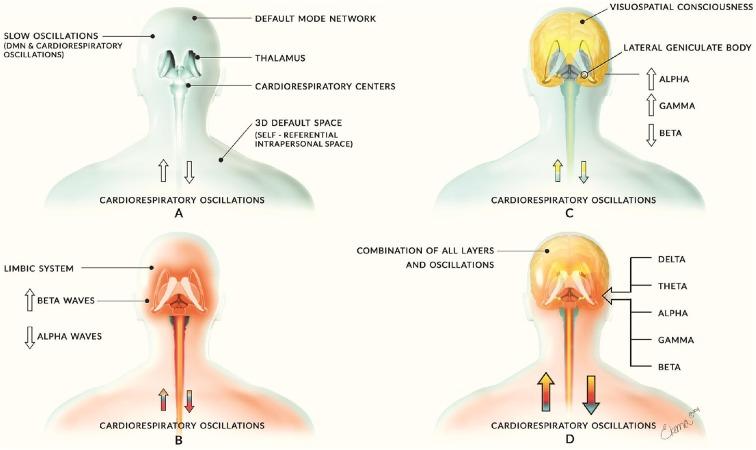


Fig. 81. Introductory model of layered activity. Panel (A) illustrates the base layer of slow neural oscillations of the Default Mode Network (DMN) and cardiorespiratory activity. This creates a foundation for all other layers of oscillatory activity and is depicted by the blue coloring.

### Panel (B) shows the second layer of middle-frequency activity largely consisting of limbic activity and is depicted by red coloring.

### Panel (C) reveals the corticothalamic feedback loops involved in cognitive and consciousness processes and is illustrated with yellow coloring.

### Panel (D) combines these layers to form the sum of human neural activity consisting of all neural and physiological oscillations. The multi-colored arrows of each person represent the layers interacting with the cardiorespiratory system with the appropriate color for each layer.

The bi-directional dynamic interactions between the layers include the modulation of high-frequency local activity by large-scale, lower frequency layers as well as the propagation of this local activity to other networks or into global availability by the lower layers. In the higher layers, the phase-locking (synchronization) characteristics of the waves are related to conscious phenomenology while the power of the waves is related to nonconscious encoding and processing .Synchronization is a key physiological component of consciousness. The layers together form a metastable bioelectric architecture suggested to be isomorphic to the contents of consciousness consisting of a global synchronization of local high-frequency activity coordinated and mediated by the low-frequency activity and the thalamus. Hierarchy exists in the global bioelectric architecture, and the complex structure of phenomenal experience The body, is superimposed onto a representation quality of the self or internal world while the others are superimposed upon a representation of the external world. Abstract concepts such as thoughts and feelings are superimposed into this phenomenal structure in a more abstract sense but still reside within the 3D space and as a component of the representation of the self. All phenomenal content is coordinated perfectly in time and unified in space. Slower oscillations provide a greater wide-spread resonance in contrast to the distinctly localized effects of faster oscillations. This makes them more suited to act as an organizing and unifying influence. Cross-frequency coupling of faster oscillations with the slow ones is suggested to couple active neural assemblies. Slow oscillations produce large, synchronous membrane potential fluctuations in independent neurons throughout brain-wide networks while faster oscillations produce much milder fluctuations in a smaller, more localized extent of cells.

### The diversification of emotional experience (beyond primordial emotions) throughout evolution may have developed not only to serve communicative functions but facilitate a proper mental and behavioral response to solving a diverse range of adaptive problem domains that influence the chance of reproductive success. Emotions are phylogenetic neural algorithms that facilitate decision making and behavior by providing approximate solutions to potentially complex survival-relevant situations in which an optimal behavior is not neurocomputationally tractable. Emotions such as happiness and sadness may be cognitively and phenomenally entrained upon the primordial sensations of safety or satiation.

### Figure 4

### Fig.82.Patterns neural oscillations in various neurological states. This figure illustrates the distinct oscillatory patterns that occur in the average person. Each panel shows not only oscillations in the central nervous system but non-neural oscillations of the heart and lungs. As the thalamus is proposed as a central hub for thalamocortical oscillations in the central nervous system, it has been placed as the center of the neural grids shown in each person. The density of each grid represents the average frequency of oscillations across the cortex, lungs, and heart, with higher densities representing higher frequencies. Surrounding the thalamus is a colored representation of the level of limbic system constraint on cortical activity of which deep purple represents the most limbic constraint. In the deep sleep state, a limbic constraint is eliminated as there is no behavioral cognitive activity. This is represented by an olive color. Global membrane potential and autonomic tonic are represented by the color of the person’s skin.

Synchronisation has become a major scientific tool to explain biological order at many levels of organisation. Synchronised and suprathreshold oscillatory neuronal activity within and between distributed neuronal assemblies is acknowledged as a fundamental mode of neuronal information processing. Coherent neuronal oscillations correlate with all basic cognitive functions, mediate local and long-range neuronal communication and affect synaptic plasticity. Two different kinds of physical substances significantly interact with each other. Purposeful coupling of matter and waves occurs in sub-cellular fields, resulting in self-organization.The word *synchronous* is derived from Greek. It literally means “occurring in the same time”. Synchronization is a universal phenomenon that “can be understood within a common framework based on modern nonlinear dynamics” and characterized as “adjustment of rhythms of oscillating objects due to their weak interaction”. This occurs when two or more autonomous objects with different rhythms adjust their rhythms in relation to one another. This definition implies the following inclusion or exclusion rules.For synchronization to occur, the objects must be oscillators and autonomous systems.

The fact that two variables have similar frequencies is not enough to imply that they are synchronous. The objects must be open systems that receive signals from their environment and interact with other objects, such that if these environmental signals are removed, the objects will no longer oscillate in common rhythms. For example, the circadian cycle (the internal biological clock) is influenced by various factors such as exposure to light and temperature. If these signals are removed, the circadian cycle of an organism will deviate from the “normal” 24-h rhythm. Autonomous oscillators can exhibit various forms of rhythms such as a sine-like waveform or short pulses. The rhythm is determined by the properties of the system itself. A synchronized object adjusts its rhythm in conformity with the rhythms of other objects. When two synchronized oscillating systems are separated from each other, they will continue to oscillate in their own rhythms. Rhythms of oscillating systems can be quantified in various ways. One common means of quantifying a system’s rhythm is to count the number of oscillation cycles per time unit, i.e., to measure the frequency of the cyclic oscillations. When synchronization occurs, the frequencies of two or more oscillating objects are *locked*. For example, experiments with pendulum clocks have shown that when two independent, non-identical clocks, with different oscillation periods, are placed in proximity to each other, they adjust their rhythms and start to oscillate with a common period. This type of phenomenon is often referred to as “frequency entrainment” .

*Phase locking* is a term used for describing the onset of a certain relationship between the phases of two synchronized self-sustained oscillators. Phases can be locked such that the oscillators are synchronized to move in the same direction (in-phase locking), opposite direction (anti-phase locking), or any variations in between (e.g., moving in the same direction but with a constant frequency lag between the oscillators).Mathematically, phase locking does not mean equality of phases but rather phases that keep the same relationships to each other over time. When two oscillating objects are synchronized, their motions are not necessarily identical. In the global (all-to-all) synchronization, coupling occurs when there is an ensemble of mutually-coupled oscillators in synchronization. An example of such a self-organizing system is a large population of fireflies flashing in synchrony, or a large audience in a theater applauding in synchrony. An attuned listener in an audience notices how synchronization is formed through a series of rather fast (several oscillatory periods) transitions from noise to a rhythmic, nearly periodic, applause, culminating in synchronized applause.In cases of global coupling, each individual responds to the collective behavior (e.g., audience applause or fireflies flashing) of the whole population, rather than to another individual in the group. When the differences between the individual frequencies are large, the rhythms are incoherent. As the differences between frequencies begin to decrease, at some critical threshold the system spontaneously freezes into synchrony.Synchronization measurement consists of analyzing the relationships between the phases and frequencies of interacting objects. The phases may be measured by identifying markers in a time series. For example, in electrocardiography (ECG) measurements, every normal cardio-cycle contains a sharp peak that can be localized in time. The time interval between two such peaks corresponds to one complete cardio-cycle. Synchronization is not a state but instead a process of adjustment of phases and frequencies, multiple measurements are required to establish the presence of synchronization.

Emotions are composite-dynamic phenomena, which involve interactions between physical properties (such as muscle contractions) and non-physical ones (such as cognitive perceptions), occurring over time and space dimensions. Diverse theories of emotions have been developed in various disciplines, adopting a multitude of theoretical lenses. Emotions at the individual level are governed by social interactions. Social interactions are particularly integral to emotion in situations in which multiple people are sharing an experience. Emotional climate is produced during social encounters from which participants develop solidarity or group belongingness, through rhythmic coordination of gesture and speech, mutual focus of attention, production of collective effervescence through group laughter and emotional attunement, and emotional energy. As a ritual outcome, collective effervescence is a state of heightened group experience whereby the group shares the same emotions (e.g., joy) and ideas. Through this process, shared ideas become symbols representing the group’s interactions. The heightened emotional state experienced in forming these shared ideas flows on to the emotional energy experienced by individuals

Humans can act as autonomous oscillating objects that synchronize on the group level, contain and regulate internal oscillating subsystems, as in the case of the synchronization of heart pacemaker cells or the circadian cycle. If viewed as oscillating objects in an emotional context, humans are autonomous, open and self-regulated systems. When two individuals are separate from each other, they continue to generate independent emotions. Humans’ emotions are highly dependent on environmental signaling. Specifically, the psychological, sociological and biological perspectives all acknowledge that emotions are responsive to signals from both the internal and external environment. Humans are non-identical, and they are self-regulating systems. Emotions are regulated both internally and externally.In order for a synchronization model to apply to human emotion, the oscillation of emotion must be characterized by rhythms. All aspects of human physiology exhibit rhythms. The most apparent rhythms are those of the 24-h cycles of wake and sleep; times of peak hunger; and levels of cortisol, a stress hormone, typically exhibiting a steep decline throughout the day and is regenerated during sleep. The various rhythms exhibited by humans are governed by external and internal physiological signals, or environmental cues.

Human rhythms are not restricted only to physiological patterns. Various studies have shown the existence of emotional diurnal rhythmic cycles consisting of positive and negative emotions. Positive emotions reached their peaks at noon and at about 7 p.m.; in the latter case, the higher levels of positive emotions persisted throughout the evening. Negative emotions reached their peaks at 10 a.m. and at 4 or 5 p.m. A synchronization framework is useful for elucidating processes of *emotional contagion*, a phenomenon in which individual emotions spread among members of a group to become a collective emotion and serves to explain how the emotions experienced by individuals can lead to the development of a collective climate and emotional attunement”. The theory of synchronization offers means of measuring both emotional contagion (the process by which individual emotions interact) and attunement (the outcome state), by measuring the temporal and spatial processes of frequency adjustments related to emotions. (504-507)

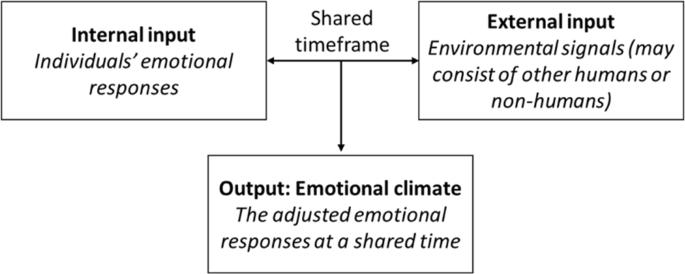


Fig. 83. Interactional processes leading to the development of emotional climate: a representation of the processes contributing to EC development that takes into account a synchronization framework. In this context, an emotional climate state arises as an outcome of individuals’ adjusted responses to a common set of environmental signals in a shared timeframe. The signals may consist of inputs by other individuals, a one-off event, a process, or a social structure (508)

The quantum processes in protein dynamics and coherent ordering in cell cytoplasm suggest that microtubules function as quantum computational devices, and that mesoscopic and macroscopic quantum states are characteristic for living systems. Coupling is the key mechanism in information transfer between the energetic mind and brain. The exceptional electrical polarity of biological objects and long range interactions play a basic role in the endogenous electromagnetic field generated by the excited longitudinal polar oscillations of microtubules in eukaryotic cells. Electromagnetic coupling is a mechanism of information transfer between individuals. It has been proposed that this energetic information exchange comprises a form of cardioelectromagnetic communication. The electrodynamic field plays an important role in establishing coherence, directional transport, organization of morphological structures, interactions, information transfer, and brain activity. (509-512)

Cancer transformation is in a way a pathological reduction of the coherent energy state. Malignancy, local invasion or metastasis are a direct consequence of mitochondrial dysfunction and disturbed microtubule polar oscillations in the generated electromagnetic field . Electromagnetic coupling is a mechanism of information transfer between individuals. Psychophysiological coherence refers to a synchronisation between positive emotions, and cardiovascular, respiratory, immune and nervous systems. From cardiovascular perspective, it is characterised by a heart rhythm pattern of elevated amplitude in low frequency heart rate variability of around 0.1 Hz, indicating harmony between sympathetic and parasympathetic divisions of the autonomic nervous system (ANS). (513-515)

From immune and hormonal system perspective, it is associated with dehydroepiandrosterone (DHEA), an energy renewing growth hormone that balances the stress hormones. From neurophysiological perspective, it synchronises with the alpha band width on the electroencephalograph. Psychophysiological coherence has emotional, social, mental, spiritual, ecological and performance benefits. The heart, generates the most powerful, comprehensive, rhythmic electromagnetic field and like the orchestra conductor, synchronises neurological, biochemical, biophysical and energetic information of nerve impulses, neurotransmitters, hormones, pressure waves and electromagnetic field interactions. (516-517)

Derived from Latin term movere [to move], the word “emotion” literally means “energy in motion”. In phenomenological terms, emotion is the experience of moving energy through the bodies generating ANS related physiological and mental reactions, such as strong feelings of love, joy, sorrow or anger. Feelings refer to a vast array of subtle conscious experiences and sensations. In itself, emotional energy is neutral. It is the physiological reactions, feelings and thoughts that give the meaning to the emotion. Reactive emotional energy manifests in brain activity before thought. Humans tend to evaluate everything emotionally, perceive first and think later. From physiological perspective, the brain, heart and intestines contain biological oscillators as pacemaker cells, whose rhythms can be modified through conscious intentionality. For the brain and nervous system to function, the neural activity, which encodes information, must be stable and coordinated and the various centers within the brain must dynamically synchronize their activity for information to be smoothly processed and perceived. (518)

**Coherence:**

Brain connectivity describes the networks of functional and anatomical connections across the brain. The functional network communications across the brain networks depend on neuronal oscillations. Detection of the synchronous activation of neurons can be used to determine the wellbeing or integrity of the functional connectivity in the human brain networks. Well-connected highly synchronous functional activity can be measured by Electroencephalography (EEG) or Magnetoencephalography (MEG) and then analyzed with several types of mathematical algorithms. Coherence is a mathematical method used to determine if two or more sensors, or brain regions, have similar neuronal oscillatory activity with each other and has been assessed on the similarity of the frequency content across EEG sensors and how coherent or connected specific locations in the brain are networked together in several different neurological disorders after it has been imaged in the brain. Statistical analysis can be performed on the coherence results to verify evidence of normal or abnormal network activity in a patient.The human brain is a vast network of connected pathways that communicate through synchronized electric brain activity along fiber tracts. The synchronized activity within this neuronal network can be detected by MEG and EEG then imaged using network connectivity analysis of the brain are performed to map out the communication networks needed for the brain to function. There are specific regions specialized for processing certain types of information in the brain that are connected and communicate with other specialized regions across networks in the brain. Neurological disorders and tumors can disrupt brain functions. Treatments and remediation have been shown to change how the brain functions. Neuroimaging connectivity techniques for quantifying the brain networks use signal processing techniques. There are three connectivity network types that are used to investigate communication within and across the brain. These network connection types are categorized as Structural, Functional and Effective. Within these categories several different imaging hardware equipment and software programs are used to detect, measure and quantify the integrity of the network.

*Structural connectivity* is based on detection of the fiber tracts that physically connect the regions of the brain. These are the anatomical network maps that indicate possible pathways that the signals can travel on in the brain . *Functional connectivity* identifies activity brain regions that have similar frequency, phase and/or amplitude of correlated activity. These areas may be involved in the resting state (i.e. task independent) or higher order information processing (i.e. task dependent) that is required for sensory responses, motor responses and intellectual or emotional processing.*Effective connectivity* uses the functional connectivity information and goes one step further and determines the direct or indirect influence that one neural system may have over another, more specifically the direction of the dynamic information flow in the brain. Effective and Functional Connectivity measurements can be analyzed in the Frequency Domain with methods such as Coherence and Phase synchrony or in the Time Domain with methods such as Correlation and Granger Causality. Coherence and Phase synchrony are mathematical methods for quantifying frequency and phase dependent correlations of brain activity measured by two or more brain sensors. Functional connectivity does not determine the specific direction of information flow in the brain. These regions have similar signal content and are connected. This type of connectivity analysis is based on brain signals recorded by Electroencephalography (EEG), Magnetoencephalography (MEG), Functional Magnetic Resonance imaging (fMRI) and Positron Emission Tomography (PET). Effective connectivity determines which brain location is sending and/or receiving information and this can be calculated using mathematical techniques such as Granger causality, Hilbert transform, transfer entropy and correlation. Brain signal information for effective connectivity can be found in brain activity recorded by EEG or MEG as these techniques have high temporal resolution to resolve the dynamic flow of information.

Brain networks are made up of populations of neurons that function in unison to send signals to other parts of the brain. Neurons communicate with other neurons by releasing one of over 50 different types of neurotransmitters in the brain, excitatory (stimulate the brain) or inhibitory (calm the brain). Voltage-gated ion channels generate action potentials and periodic spiking membrane potentials which produce oscillatory activity and facilitate synchronous activity in neighboring neurons. These action potentials activate a neighboring population of neurons which affect other populations of neurons at a distance creating a network of connectivity.Coherent neuronal communications are based on neurotransmission dynamics dictated by major neurotransmitters ( glutamate, GABA, acetylcholine, dopamine, adrenaline, histamine, serotonin and melatonin). Coherence across a network occurs when the populations of neurons are active at the same time or in a time-related fashion with other populations, not a relationship of activity between individual neurons. Synchronized activity of a significantly large population of neurons can rise to large electric field oscillations with a concomitant magnetic field, which can be detected by EEG or MEG respectively for calculating connectivity. They are both indirect measures of neuronal activation with low temporal resolution on the order of seconds. MEG measures the ionic current flow inside the neuron (primary currents) while EEG measure the return or volume currents outside the neuron (secondary currents). Functional and effective connectivity techniques are dependent on calculating the communication of active neural signals that are oscillating over short and long periods of time. Coherence is a linear mathematical technique for calculating neuronal networks in the frequency domain quantifying the frequency and amplitude of the synchronicity of neuronal patterns of oscillating brain activity measured between spatially separated two data sets, scalp electrodes (Electroencephalogram) or coils (Magnetoencephalogram) within a set frequency band to determine if the signal content of two inputs are the same or different. If the signals measured by two electrodes or coils are identical then they have a coherence value of 1; depending on how dissimilar they are the coherent value will approach 0.

In sensor space if signals are in phase then their amplitudes would add, if they are out of phase the signals would subtract reducing the coherence value. In source space the amplitude of the underlying source can be used to determine the strength of the connectivity. The result is a symmetrical matrix that provides no information on directionality. Coherence measure is used to determine if different areas of the brain are generating signals that are significantly correlated (coherent) or not significantly correlated (not coherent). Phase synchrony is another math signal processing technique used for short duration events such as an evoked event that estimates the synchrony of oscillations in EEG and MEG data and measures how stable the phase difference (small or large) varies over a short period of time and determines how much the two locations (recording sites) are interacting within a very narrow time window (milliseconds). . This is a process where two or more cyclic signals tend to have oscillator activity that are the same (in phase) or out of synchrony (out of phase) by a relative phase angle. Phase relationships can be examined by testing the stability of the signals through phase differences across trials (phase-locking) over a single electrode or between pairs of electrodes. This approach can yield estimates of the precision of local and long-range synchrony independent of the amplitude of oscillations.

Coherence and Phase synchrony are the building blocks for understanding brain connectivity, how the populations of neurons communicate around a network. To determine if different areas of the brain are connected using EEG or MEG, a frequency analysis is performed to convert the original EEG or MEG data into its frequency content, then coherence analysis is used to obtain information about the temporal relationships of frequency components of populations of neurons at different recording sites (electrode or coil). The results of the coherence analysis are displayed in sensor space using a template of the head with lines connecting the electrodes or coils that are coherent with each other and represent the connected areas of the brain. The concept of coherence pertains to the homeostatic balance present in a healthy individual, representing harmonious interactions of the body׳s subsystems, external relationships, and interactions and implies a global order, structure, harmony, and alignment within and amongst systems and refers to the patterns of biological rhythms in coupled states, resulting in synchronized oscillations.

Coherent electromagnetic fields can form stable patterns. Many biocommunicative processes in biology rely on coherent oscillations to induce biochemical reactions. Quantum coherence involves a precise phase-correlated coupling between body rhythms such as the constant communication between the human heart and the rest of the body. Increased coherence in a single system, such as in the electromagnetic field of the heart, can drive coordination of related physiologic systems within the body. An individual׳s emotional states can be directly correlated to cardiac electromagnetic coherence. Biological systems are dynamical, constantly exchanging energy and matter with the environment in order to maintain the non-equilibrium state synonymous with living. Developments in observational techniques have allowed to study biological dynamics on increasingly small scales. Such studies have revealed evidence of quantum mechanical effects, which cannot be accounted by classical physics, in a range of biological processes.

Quantum mechanics describe the properties of subatomic particles, atoms, molecules, molecular assemblies and operate on the nanometre and sub-nanometre scales at the basis of fundamental life processes such as photosynthesis, respiration and vision. Quantum coherence describes the correlations between the physical quantities describing the wave-like nature of the objects when they interact. All matter—animate or inanimate—is quantum mechanical, being constituted of ions, atoms and/or molecules whose equilibrium properties are accurately determined by quantum theory.

Positive coping mechanisms and intention have been shown to increase cardiac coherence, whereas negative emotions result in diminished coherence. A collection of studies entitled direct mental interaction with living systems (DMILS) demonstrate the significant and measurable effects on human intention. When the clinician maintains focused attention on the patient, “intentionality and consciousness are united in the energetic field of emerging possibilities.”

The ability to alter one’s emotional responses is central to overall well-being and effectively meeting the demands of life. One of the chief symptoms of events such as trauma, that overwhelm our capacities to successfully handle and adapt to them, is a shift in our internal baseline reference such that there ensues a repetitive activation of the traumatic event. This can result in high vigilance and over-sensitivity to environmental signals which are reflected in inappropriate emotional responses and autonomic nervous system dynamics. The psychophysiological coherence model draws on dynamical systems theory and predicts that different emotions are reflected in state-specific patterns in the heart’s rhythms independent of the amount of HR and emphasizes the healthy physiological variability, feedback, inhibition, and reciprocal interactions among a hierarchy of nested neural systems that underlie a complex psychophysiological system for maintaining stability and adaptability to complex changing environments and social demands. The coherence model suggests that the amount of heart rate variability (HRV) is mediated by efferent vagal fibers and reflects self-regulatory capacity. Neural processes have been routinely described in terms of manipulations of discrete “states,” “symbols,” or “codes” . The prevailing analogy is the notion of “digital computing”: The brain, as a mosaic of disjoint, independent functional units, “processes information” by flexibly rearranging between these different states. The information-processing framework contains latent anthropomorphic thinking: coding, message-passing, and communication, which are metaphors relying on the intuitive familiarity of social interactions.

An organism is a constantly changing web of biophysical and electrochemical interactions. A natural consequence of this organization, that is a manner in which stimuli are processed, depends on the state of the organism at the precise moment when the stimulus arrives. The brain is inherently dynamic, and cannot be understood with static descriptions. It is essential to examine not only how activity levels in voxels change over time, but also to model how voxels influence each other. The majority of approaches used in modern neuroimaging contain a hidden assumption of stationarity assuming that the brain is always in the same position in state space when a stimulus arrives. In the Central Autonomic Network model in which the subcortical structures influence the oscillatory output of cardiorespiratory centers in the brain stem. The term psychophysiological coherence is used in the context when more coherent heart rhythms naturally emerge due to positive experience, or through the self-activation of positive emotions. Techniques associated with different subjective inner states such as paced breathing increase cross-coherence between breathing and heart rhythms via brainstem centers in the medulla, without shifting the activity in higher level sub-cortical structures to mediate the structure of different patterns in the HRV waveforms and the increased or decreased coherence related to emotional states. Since the coherence model is focused on specific approaches to increase people’s ability to self-regulate, the HRV coherence measure is used in the context of facilitating skill acquisition of self-regulation practices that lead to measurable increases in HRV coherence.Concepts embraced by the term coherence have been identified as central to fields such as quantum physics, physiology, and social science. There are different types of coherence, although the term always implies a harmonious relationship, correlations and connections between the various parts of a system. A specific measure derived from heart rate variability (HRV) provides a measure of physiological coherence.

Another type of coherence, social coherence, relates to the harmonious alignment between couples or pairs, family units, small groups, or larger organizations in which a network of relationships exists among individuals who share common interests and objectives. A high degree of social coherence is reflected by stable and harmonious relationships, which allows for the efficient flow and utilization of energy and communication required for optimal collective cohesion and action. Social coherence requires that group members are attuned and emotionally connected with each other, and the group’s emotional energy is organized and regulated by the group as a whole. A number of studies have explored various types of synchronization in infants, pairs and groups, indicating that feelings of cooperation, trust, compassion and increased prosocial behaviors depends largely on the establishment of a spontaneous synchronization of various physiological rhythms between individuals.

Providing feedback of HRV coherence level at the individual level can improve self-regulation. The following hypotheses suggested:

(1) providing feedback of individual and collective HRV coherence and the degree of heart rhythm synchronization increase group coherence, and heart rhythm synchronization among group members.

(2) Training in techniques to increase group coherence and heart rhythm synchronization correlate with increased prosocial behaviors, such as kindness and cooperation among individuals, improved communication, and decreases in social discord and adversarial interactions.

(3) Biomagnetic fields produced by the heart are a primary mechanism in mediating HRV synchronization among group members.

The evolutionary anthropology suggests that the primary drivers of evolution of the human species are their advanced capacities for social interaction and cooperation and social connections and secure attachments, independent of maturational stage, and culture. People spend a sizeable amount of their time communicating, interacting and performing tasks with others. Being a member of various groups across one’s lifespan is an inescapable aspect of his/her lives especially the most precious moments of intimate connection.Terms such as social coherence, social support, social connection, social functioning, loneliness, and social isolation describe various aspects of human social functioning. Developing skills and behaviors and being able to successfully connect, cooperate and collaborate with others are of great importance. Social incoherence not only affects the way we feel, relate, and communicate with others but also affects physiological processes that disrupt good health.

Social coherence and connection should be the most important public health priorities. Individuals experiencing social or cultural changes, or living in circumstances of social instability, disorganization isolation and loneliness are at increased risk of acquiring numerous diseases, especially for heart disease than lack of exercise, smoking, excessive alcohol consumption, and obesity combined. Numerous studies of various populations, regardless of geography or culture, have found that when individuals have close and meaningful relationships, they have reduced risk of mortality and susceptibility to chronic and infectious diseases, and improved outcomes in pregnancy and childbirth and live happier and healthier lives. The importance of social coherence for people’s health, as well as for team and organizational performance and societal harmony highlights the need for programs that strengthen people’s capacity for mental and emotional self-management and focus on increasing social coherence. to address what ails both individuals and groups in situations of social incoherence, there are practical steps and practices that can increase and stabilize group coherence and resilience in organizations, teams, schools and communities.In physics, cross-coherence expresses the amount of synchronized activity among separate oscillating systems. When two or more systems have the same frequency range, they can become phase or frequency-locked. In the human body when respiratory, blood pressure and heart rhythms, shift into an optimal state at the resonant frequency of the cardiovascular system.

Synchronization is an aspect of coherence that describes the coordination of distinct events that are acting in harmony whether concurrently or sequentially in an enduring patterned organization, between two or more events. In the context of social coherence, various mathematical measures of cross-coherence can be used to assess the degree of pairwise synchronization occurring between physiological rhythms, such as heart rhythms and brain waves of two or more individuals.The term *auto-coherence*, called also auto-correlation in mathematics, describes the order in a single waveform produced by an oscillating system, or the output of multiple complex interacting systems. For example, when the rhythm of the heart, exhibits sine wave-like output, the more stable the amplitude, frequency, and shape of the wave, the higher the degree of auto-coherence. When an oscillatory system has a high degree of auto-coherence and is coupled to other systems, it can pull the other systems into increased synchronization or entrainment, which reflects a more energy efficient and healthier system. To assess physiological and personal coherence, HRV analysis methods such as the frequency domain (power spectrums) and time statistical measures of variance in the inter-beat intervals (time domain) are exclusively used to quantify the amount of HRV that occurred over a specific time period.

Social or group coherence relates to pairs, families, groups or larger organizations in which there is a stable and harmonious alignment of relationships that allow for an efficient flow and utilization of energy and communication required for optimal collective action and include the degree of physiological synchronization, the capacity for coordinated action, and the number and quality of positive emotional connections, as well as harmonious cooperation in the relationships of group members. In a working group, sports team, family or business organization aligned around a common purpose or goal, member individuals exhibit a natural tendency toward good communication, cooperation and efficiency sharing common, broader group identities such as cultural, religious, or political party affiliations. When social organization is incoherent and relations are discordant, optimal coordinated action may not be possible leading to psychosocial instability and dysfunction. The smoothness or flow in social interactions depends largely on the spontaneous synchronization between individuals. When people are engaged in conversation, they unconsciously begin to synchronize their movements, vocal pitch, postures, speaking rates, and length of pauses between replies.For physiological activity of separate individuals to synchronize, a signal of some type (light, electromagnetic, sound, tactile, or chemical) must convey information between them. The visual synchronization of physical movements increases feelings of affiliation, self-esteem, compassion and altruistic behavior, rapport, and increased prosocial behavior., while during arguments, synchrony decreases.In groups, synchronization has been shown to increase conformity, cooperation and trust and the strengthening of social attachment between group members.

Brain-to-brain synchronization is a perceptual system of one brain coupled to another brain. For example, using functional magnetic resonance imaging (fMRI), synchronization between a speaker and listener’s brain exhibit joint, temporally coupled response patterns during communication. The more extensive the neural coupling between the speaker and listener pairs, the the communications is more successful. The use of magnetoencephalography (MEG), which has a higher temporal resolution than fMRI, demonstrated more rapid changes in the coupling of the listener’s and speaker’s cortical signals when interacting.HRV provides an ideal approach for evaluating interaction synchrony between individuals by looking at the synchronization of heart rhythms and ANS dynamics in real-time, as well as physiological synchronization to reflect participants’ emotional states during various types of interactions. State-specific patterns in the HRV waveforms reflect real-time emotions, for example, frustration, anger, anxiety, and appreciation using a machine learning method for pattern recognition. The maturing of physiological oscillators provides the substrate for the regulation of the sleep–wake cycle, the heart rhythms, arousal, and the real-time registration of shifts in internal states such as hunger, blood pressure, and fatigue.HRV assesses interaction synchronization on parent–infant synchrony and the coregulation of infant physiological process and emotional states through social interaction. The *in utero* development of an infant’s biological oscillator systems is critical for later synchronization with their mothers biological rhythms. During face-to-face interactions, a mother unconsciously adapts her heart rhythms to those of her infant, and the infant adapts his or her heart rhythms to those of the mother in less than a second, resulting in a biological synchronization between the accelerations and decelerations of their heart rate.

The degree of synchronization between the parent’s and child’s social interactions, their heart rhythms increase show a real-time coordination between the physiological and social processes between separate individuals. The highest degree of HRV synchronization occurr when both emotional state and vocal synchrony simultaneously take place, while gaze synchronization does not increase HRV synchronization. This synchronization does not require bodily contact or tactile stimulation and ocur as the mothers and infants are not in physical contact and do not even touch each other. A more optimal organization or coherence of the biological rhythms between parents and the first months of their infant’s life is shown to predict the development of self-regulatory and social interaction capacities later in life. Feelings of cooperation, trust, compassion and prosocial behaviors are facilitated by physiological synchronization between individuals.

Biological rhythms provide the foundation for social rhythms. The capacity to coordinate physiological rhythms lies at the heart of human emotional connections and provides the foundation for collaboration and the formation of human societies. Many teams, such as professional and Olympic sports teams or Special Forces military units may increase team coherence in-sync communicating on an unseen energetic level as “team spirit” or “bonding,” and “sense” a palpable “team energy.” For the physiological activity of separate individuals to synchronize, a visual, auditory and/or tactile signal must convey information or emotional state between them, independent of body language, or other factors. An energetic field connects individual group members directly and simultaneously distributes information to locations external to the body and people “feel” or “sense” another person’s presence between the group members. Biologically generated magnetic fields by the beating heart and radiated externally to the body may act as a carrier wave for information transfer between individuals and group members.The heart radiates a series of pulsing magnetic energy waves, that produce interference patterns when they interact with magnetically polarizable tissues and substances. The time interval between each pulse of magnetic energy varies in a complex manner. The heart’s magnetic field can be detected by the nervous systems of nearby people and animals. Providing HRV coherence feedback to facilitate skill acquisition of self regulation techniques improves a wide range of health and performance outcomes. Social coherence is defined as a stable, harmonious alignment required for optimal collective cohesion and action.

The positive feelings reflect coherent body states, meaning that "the regulation of life processes becomes efficient, even optimal, free-flowing and easy,"and the negative feelings " such as anger, anxiety and frustration are examples of incoherent states. For the brain and nervous system to function optimally, the neural activity, which encodes and distributes information, must be stable and function in a coordinated and balanced manner. Various centers within the brain must be able to dynamically synchronize their activity in order for information to be smoothly processed and perceived. Various concepts and measurements embraced under the term coherence have become central to fields as diverse as quantum physics, cosmology, physiology and brain and consciousness research and applicable to the study of human physiology, social interactions and global affairs. The most common dictionary definition of coherence is the quality of being logically integrated, consistent and intelligible, as in a coherent statement. A related meaning is the logical, orderly and aesthetically consistent relationship among parts. Coherence always implies correlations, connectedness, consistency and efficient energy utilization and refers to wholeness and global order, where the whole is greater than the sum of its individual parts. In physics, coherence describes the coupling and degree of synchronization between different oscillating systems called *cross-coherence*,. When two or more oscillatory systems operate at the same basic frequency, they can become either phase- or frequency-locked, as occur between the photons in a laser. In physiology, cross-coherence occurs when two or more of the body’s oscillatory systems, such as respiration and heart rhythms, become entrained and operate at the same frequency.

Another aspect of coherence termed *autocoherence, that* relates to the dynamic rhythms produced by a single oscillatory system,  describes coherent activity within a single system. An ideal example is a system that exhibits sine-wavelike oscillations; the more stable the frequency, amplitude and shape, the higher the degree of coherence. When coherence is increased in a system that is coupled to other systems, it can pull the other systems into increased synchronization and more efficient function. For example, frequency pulling and entrainment can easily be seen between the heart, respiratory and blood pressure rhythms as well as between very-low-frequency brain rhythms, craniosacral rhythms and electrical potentials measured across the skin.For any system to produce a meaningful function, it must have the property of global coherence. In humans, this includes the physical, mental, emotional and social systems. The energy efficiency and degree of coordinated action of any given system can vary widely and does not necessarily result in a coherent output or flow of behavior. Global coherence does not mean that everyone or all parts of a system are doing the same thing simultaneously. In complex globally coherent systems, such as human beings, there is a vast amount of activity at every level of magnification or scale that spans more than two-thirds of the 73 known octaves of the electromagnetic spectrum.

A given system operating autonomously at one level of scale, is coordinated within the whole. In living systems, there are microlevel systems, molecular machines, protons and electrons, organs and glands, each functioning autonomously, doing very different things at different rates, but all working together in a complex harmoniously coordinated and synchronized manner. Otherwise, it would be a free-for-all among the body’s independent systems, rather than a coordinated federation of interdependent systems and functions. The term *physiological coherence* describes the degree of order, harmony and stability in the various rhythmic activities within living systems over any given time period. This harmonious order signifies a coherent system, whose efficient or optimal function is directly related to the ease and flow in life processes. In contrast, an erratic, discordant pattern of activity denotes an incoherent system whose function reflects stress and inefficient utilization of energy in life processes. Specifically, heart coherence ( referred to as cardiac coherence or resonance) can be measured by HRV analysis wherein a person’s heartrhythm pattern becomes more ordered and sine wavelike at a frequency of around 0.1 hertz (10 seconds). When a person is in a more coherent state there is a shift in the relative autonomic balance toward increased parasympathetic activity (vagal tone), increased heart-brain synchronization and entrainment between diverse physiological systems. In this mode, the body’s systems function with a high degree of efficiency and harmony and natural regenerative processes are facilitated. Although physiological coherence is a natural human state that can occur spontaneously. While some rhythmic-breathing methods may induce coherence for brief periods, people can achieve extended periods of physiological coherence by actively self-generating positive emotions.

When functioning in a coherent mode, the heart pulls other biological oscillators into synchronization with its rhythms, leading to entrainment of these systems. Entrainment is an example of a physiological state in which there is increased coherence *between* multiple oscillating systems and *within* each system. Positive emotions not only "feel better “ tend to increase synchronization of the body’s systems, enhancing energy and enabling to function with greater efficiency and effectiveness. The coherence model takes a dynamic systems approach that focuses on increasing people’s self-regulatory capacity through self-management techniques that induce a physiological shift, which is reflected in the heart’s rhythms. Rhythmic activity in living systems reflects the regulation of interconnected biological, social and environmental networks and important biologically relevant information is encoded in the dynamic patterns of physiological activity. For example, information is encoded in the time interval between heartbeats (HRV) , action potentials in the nervous system and patterns in the pulsatile release of hormones which is communicated across multiple systems and synchronize the system as whole.

Self-induced positive emotions, associated with improved system performance, ability to self-regulate and wellbeing, shift the entire system into a more globally coherent and harmonious physiological mode The coherence model predicts that different emotions are reflected in state-specific patterns in the heart’s rhythms. When playing violent video games, it is found that the players had lower cardiac coherence levels and higher aggression levels than did nonviolent game players and that higher levels of coherence were negatively related to aggression. The coherent state has been correlated with a general sense of well-being and improvements in cognitive, social and physical performance. The coherence model includes specific approaches for quantifying the various types of physiological coherence measures, such as cross-coherence (frequency entrainment between respiration, BP and heart rhythms), or synchronization among systems (e.g., synchronization between various EEG rhythms and the cardiac cycle), autocoherence (stability of a single waveform such as respiration or HRV patterns) and system resonance.  A coherent heart rhythm is defined as a relatively harmonic, sine-wavelike signal with a very narrow, high-amplitude peak in the lowfrequency (LF) region of the HRV power spectrum with no major peaks in the very-low-frequency (VLF) or high-frequency (HF) regions. Physiological coherence is assessed by identifying the maximum peak in the 0.04 to 0.26 hertz range of the HRV power spectrum, calculating the integral in a window 0.030 hertzwide, centered on the highest peak in that region and then calculating the total power of the entire spectrum. The coherence ratio is formulated as (peak power/[total power – peak power]).

Social coherence, that relates to pairs, family units, groups or larger organizations in which a network of relationships exists among individuals who share common interests and objectives, is reflected as a stable, harmonious alignment of relationships that allow for the efficient flow and utilization of energy and communication required for optimal collective cohesion and action. Coherence requires that group members are attuned and emotionally aligned and that the group’s energy is globally organized and regulated by the group as a whole. Group coherence refers to the synchronized and harmonious order in the relationships between and among the individuals rather than the systems within the body.In a coherent team, there is freedom for the individual members to do their part while maintaining cohesion and resonance within the group’s intent and goals. A general theory of social communication explains the patterns of social organization common to most groups and independent of size, culture, degree of formal organization, length of existence or member characteristics. Groups have a global organization and coherent network of emotional energetic relations interconnecting virtually all members into a single multilevel hierarchy.

The HeartMath HRV coherence model,called also the Heart-Rhythm Coherence hypothesis, that has gained more traction in educational, workplace, and consumer markets due to its accessibility and broader focus on emotional self-regulation, emphasizes the facilitation of self-regulation circuits and the neural interactions between the heart and brain and the importance of the neural patterns and their stability in the afferent cardiovascular neural inputs to the brain on emotional stability and cognitive functions and suggests that in addition to the amount of cardiovascular afferent vagal traffic to the brain, the patterns and stability of afferent inputs modulate cognitive performance and self-regulatory capacity over both short (within one or two cardiac cycles) and longer time scales (minutes). High-amplitude physiological oscillations have a causal impact on emotional well-being. Blood flow timing determining brain network structure and function, with slower frequency, high-amplitude oscillations in heart rate improve brain network dynamics. This improvement occurs via fluctuations in blood flow, CO2 levels, and afferent inputs from breathing and the heart. These inputs modulate activity in brain regions associated with emotion regulation, especially prefrontal regulatory areas that are highly sensitive to physiological oscillations[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR21). Heartbeat-evoked potential amplitudes are significantly increased in numerous brain regions, including frontal areas, when participants engage in resonant frequency breathing or coherence techniques. Interventions targeting physiological oscillations have profound effects on brain function and emotional regulation.

The coherent state is characterized by a state specific higher amplitude, smooth, sine-wave-like pattern in the heart rhythm that emerges when synchronization and frequency entrainment occur between the heart rhythms, blood pressure, and respiration rhythms. This arises in the frequency range between 0.04 and 0.26 Hz of the HRV power spectrum, the coherence range in which there is increased synchronization between the brain rhythm and the cardiac cycles[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR4). The HRV coherence assessment algorithm is designed to detect the stability of the sine-wave like pattern in the heart rhythm independent of heart rate and the amplitude of the HRV rhythm. The amount of HRV decreases with age[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR24). The coherence range, that varies between individuals, changes within a session, tracking and feeding back a real-time coherence score. Therefore, the algorithm identifies the maximum peak in the 0.04–0.26 Hz range of the HRV power spectrum, calculates the integral in a window 0.030 Hz wide, centered on the highest peak in that region, then calculates the total power of the entire spectrum over a 64-second window that is updated every 5-seconds.

The Coherence ratio (CR) is formulated as: the product of two ratios: CR = (Peak Power/Total power below the peak frequency)\*(Peak Power/Total power above peak frequency) which is converted into a Coherence Score (CS) by taking the natural logarithm of CR + 1 which typically ranges between 0 and 8.The HRV coherence feedback approach includes the effect of emotional states on the heart rhythm. Emotional states such as anger and appreciation are reflected differently in the patterns of the heart rhythm and in the power spectra[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR25) and participant’s breathing rhythms co-varied with the emotions they are experiencing suggest that the brain structures above the cardiorespiratory integration centers in the dorsal vagal complex involved in emotional processing and experience (amygdala, etc.) are unconsciously modifying the breathing rhythm, which is reflected in changes in the heart rhythm.

Positive emotions, such as appreciation and compassion are associated with a highly ordered heart rhythm pattern, called a coherent rhythm. Conversely, negative emotions, including anger, frustration, and anxiety, tend to produce irregular and erratic heart rhythm patterns. These incoherent patterns manifest as jagged, disorganized waveforms, suggesting a lack of synchronized activity in the higher brain structures and between the two branches of the autonomic nervous system[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR28). Such states of incoherence have been linked to decreased physiological efficiency, increased energy expenditure, and potential long-term wear on bodily systems. The heart rhythm coherence referred to as heart-brain coherence, heart coherence, cardiac coherence, vascular system resonance and entrainment improves self-regulation and sustained by positive emotions.

Many of the clinical, workplace and educational studies using HRV coherence feedback technology to facilitate skill acquisition of self-regulation techniques designed to shift one’s physiology into a more coherent state when they are experiencing stress or wanting to enhance performance, have found significantly improved key markers of health, wellness and performance in many health-care, law enforcement, corporate, military and educational settings. Daily biofeedback sessions can increase resting state HRV and shape the brain circuits that help control HRV and regulate emotion and increase functional connectivity between the medial prefrontal cortex and left amygdala with increased down-regulation of activity in somatosensory brain regions during an emotion regulation task, indicating that modulating heart rate oscillatory activity changes emotion network coordination in the brain[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR52) .

The heart’s optimal function relies on a complex interplay between the central nervous system and the intrinsic cardiac nervous system (ICNS) located within the heart itself. The intrinsic cardiac nervous system has both short-term and long-term memory functions, which can influence HRV and afferent activity related to BP, rhythm, rate, and hormonal factors and exhibits both short-term and long-term memory capabilities, which can modulate heart rate variability (HRV) and afferent activity associated with blood pressure, cardiac rhythm, heart rate, and hormonal factors. Comprising sensory, interconnecting, afferent, and motor neurons, the ICNS can function autonomously from central neuronal control. The extensive network of these intrinsic cardiac neurons is so sophisticated that it has been characterized as a “little brain” within the heart, highlighting its importance in cardiac regulation and adaptation. In long-term recordings from single afferent neurons in beating hearts and simultaneously from extrinsic cardiac neurons, it is discovered that the lower frequency rhythms are generated from feedback loops between the sensory neurons in the heart and the intrinsic cardiac nervous system[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR60). These rhythms are associated with deeper states of relaxation and cardiovascular system efficiency as the stability and frequency of these low frequency rhythms are disrupted by stimulation of efferent sympathetic inputs to the intrinsic cardiac nervous system[https://www.nature.com/articles/s41598-025-87729-7](https://www.nature.com/articles/s41598-025-87729-7#ref-CR17).

By teaching techniques that increase coherence, combined with HRV feedback practice, these interventions have been shown to improve emotional regulation, cognitive function, and overall well-being. Physiological coherence, associated with a sine wave-like pattern in the heart rhythms, an increase heart/brain synchronization and entrainment between diverse physiological systems, is a natural human state which can occur spontaneously during positive emotional experiences and sleep. While specific rhythmic breathing methods may induce coherence and entrainment for brief periods, the active generation and maintenance of a positive emotion can produce extended periods of physiological coherence as a result of changes in the patterns of afferent information flowing from the heart to the respiratory and other brain centers. The physiological coherence mode driven by a positive psychological state is called psychophysiological coherence.

The capacity to self-generate positive emotional states and quickly shift to a physiologically coherent mode at will can be developed and refined through the use of practical tools and techniques developed by the Institute of HeartMath, such as Freeze-Frame, Heart Lock-In and Cut-Thru. This shift allows people to arrest the physiological stress response and prevent the psychological wear and tear normally associated with various stressors. Observed benefits include: reduced psychological stress and negative affect; decreased anxiety and depression; increased positive affect; improved psychosocial functioning; enhanced cognitive performance; increased emotional intelligence; reduced tension and physical stress symptoms; decreased burnout and fatigue; enhanced physical vitality; increased humoral immunity; reduced cortisol and increased DHEA. Practice of these techniques has been associated with health improvements in a wide variety of clinical conditions including reduced trait anxiety and pathological symptoms in individuals with HIV; reduced depression and improved functional capacity in elderly patients with congestive heart failure; the restoration of normal blood pressure levels in hypertensive individuals and improved glycemic control and quality of life in patients with diabetes.

Finger photoplethysmography (PPG) signals have been utilized to determine cardiovascular variability in an fMRI design, which is then processed using spectral paradigms. Accurate assessment of cardio-vagal activity is obtained by calculating the spectral power of heartbeat variability in the high-frequency band (HF: 0.14-0.40 Hz. involving the integration of Muscle Sympathetic Nerve Activity (MSNA) signals—sourced from the common peroneal nerve—with BOLD signals derived from fMRI. An increase in signal intensity within the rostral VLM region and decrease in regions are linked with the NTS and caudal VLM. A positive correlation between MSNA and BOLD signals have been uncovered in several other cerebral regions, including the left dorsomedial hypothalamus (DMH), bilateral ventromedial hypothalamus (VMH), left insula, bilateral dorsolateral prefrontal cortex, bilateral posterior cingulate cortex (PCC), and bilateral precuneus.

The central autonomic network (CAN) is a group of brain regions that are functionally connected to the activity of peripheral autonomic nerves: Parasympathetic CAN (i.e., the CAN projecting onto parasympathetic branches) and sympathetic CAN (i.e., the CAN projecting onto sympathetic nerves) and consist of cortical (medial prefrontal cortex (mPFC), cingulate cortex (CC), insula, etc.), subcortical. Each component in this network plays a distinct role in supporting the complex process of autonomic regulation under various physiological circumstances. The insula and cingulate cortex are part of the and brainstem regions (periaqueductal gray matter of the midbrain (PAG), and several nuclei in the medulla oblongata and pons and are functionally. Together with the amygdala, mPFC, frontal cortices are crucial in regulating homeostatic-interoceptive functions that involve autonomic dynamics . This leads to the theory that the brain’s visceromotor and viscerosensory representations form the foundation for emotion perception. The central autonomic network (CAN) is an intricate system of brainstem, subcortical, and cortical structures that play key roles in the function of the autonomic nervous system. The CAN has crucial implications for the development and advancement of various disorders. Disturbances in the brain-heart interaction and the subsequent changes in communication between the ANS and CNS have been linked to neurological injury, mood disorders, schizophrenia, anxiety. Vagal nerve stimulation has been proposed as a treatment for epilepsy and depression. Biofeedback based on cardiovascular data has proven to be effective in regulating negative emotions and psychological symptoms.From a functional and methodological perspective, the CAN can be divided into three hierarchical levels. The spinal cord contains neuronal bodies and projections which direct segmental reflexive control of ANS function. At the level of the brainstem, the NTS, the ventrolateral medulla (VLM), and parabrachial nucleus of the dorsolateral pons are implicated in immediate and reflexive control of circulation, respiration, and gastrointestinal function. The PAG in the midbrain region integrates autonomic control with pain modulation and behavioral responses to stress and sleep. At the level of the forebrain, the hypothalamus integrates autonomic, endocrine, and sleep functions, and the anterior limbic circuit [anterior cingulate cortex (ACC), amygdala, and insular cortices] integrates bodily sensation and pain with emotional and goal-related autonomic responses. Forebrain structures are implicated in modulation of ANS reflexive functions in response to internal and external environments.

The coherence model informed the development of a number of mental and emotional self-regulation techniques, designed to be used in the moment when the person is emotionally triggered or is experiencing stress, or to better prepare for upcoming challenging events. The use of these techniques shifts the user’s physiology into a more coherent and balanced functional state which is reflected in the patterns of the heart’s rhythm. By reinforcing this natural coupling in the sub-cortical regulatory system, the self-activation of a positive feeling can automatically initiate an increase in cardiac coherence, while at the same time, a physiological shift resulting from heart-focused breathing can help facilitate the experience of a positive emotion.The demands of both mental and physical activity are integrated with the dynamic control of internal bodily states. The set of neural interactions that supports [autonomic regulation](https://www.sciencedirect.com/topics/neuroscience/autonomic-regulation) extends beyond afferent-efferent homeostatic reflexes (interoceptive feedback, autonomic action) to encompass allostatic policies reflecting more abstract and predictive mental representations, accessed as conscious thoughts and feelings. Historically and heuristically, reason is contrasted with passion, cognition with emotion, and ‘cold’ with ‘hot’ cognition. Investigations of psychological processes have been pursued during states of musculoskeletal quiescence and relatively insensitive to autonomic interaction with attentional, perceptual, mnemonic and decision-making processes.

Autonomic psychophysiology has highlighted the bidirectional coupling in the context of emotion, autonomically mediating changes in inner bodily physiological states are viewed as intrinsic constituents of the expression of emotions, while their feedback representation underpin emotional and motivational feelings. The brain systems, encapsulated by the notion of central autonomic network, provide the interface between cognitive, emotional and autonomic state and span the neuraxis, overlap with the more general governance of [behaviour](https://www.sciencedirect.com/topics/neuroscience/behavior-neuroscience), and represent district levels of proximity to survival-related imperatives The notion of autonomic nervous control supposes an independent, automatic self-governing system responsible for the maintenance of body physiology, through low level, orchestrated patterns of reflex responses.By sensing changes in biomechanical, biochemical and thermal signals (via interoceptors and viscerosensory afferents), the action of the autonomic nervous system adjusts organ function to ensure that these measures are kept within stable ranges that are necessary for the organ-level, *homeostatic* integrity of the body. Autonomic control also supports a complexity of organism-level behaviours that are necessary for survival and reproduction. Autonomic responses facilitate motor action and recovery states (in a peripheral and reactive way). Interoceptive signalling gives rise to distinct motivational states that are associated with affective valence (pleasant/unpleasant; reward/punishment) and engender distinct patterns of autonomic and behavioural responses, which reflect the prioritization, selection, and execution of adaptive strategies that are predictive and *allostatic* (ensuring stability through change).

The autonomic nervous control is integrated with affective, motivational and cognitive processes, reflected in brain function. The brain integrates autonomic control and its interoceptive feedback with cognition and emotion in a normative and adaptive way. Mental stress describes a maladaptive state which, may exert detrimental effects on the individual depending on the intensity, number, persistence of the stressor(s), and/or evoked neurophysiological and psychological responses.Autonomic activity supports a variety of functions, including social and emotional communication, and reproduction to promote the health of the body through homeostasis and allostasis. Within the brain, the brainstem and hypothalamus are the main hubs for homeostatic control, where fine adjustments can take place through endocrine, autonomic, and somatomotor responses, and by predictive buffering. If a threat to internal states, or a deviation from the normal range of physiological functioning (triggered by changes in the external – e.g. hot weather – or internal – e.g. low blood sugar level – environment) is signalled, this will trigger a concerted set of responses to ensure the internal milieu is kept constant. This temporary adjustment is termed as allostasis. Motivational, emotional, and cognitive processing can be viewed as an extension of allostatic adjustment, expressed along a behavioural spectrum from simple food-seeking to complex expressions of social emotions. This capacity for human autonomic regulation to engage and interact with emotional and cognitive systems represents a complexity relative to non-human animals. Human autonomic control is bound to memory, education and culture, evidenced by the fact that the endocrine, autonomic or somatosensory responses to a specific physical or psychological challenge are individualised.

The central autonomic network (CAN), that consists of interconnected areas including the anterior cingulate and insular cortices, amygdala, periaqueductal gray, pedunculopontine nucleus (PPN), parabrachial nuclear complex, nucleus of solitary tract, ventrolateral medullary reticular formation, and rostral ventromedial medulla and raphe nuclei, are distributed throughout the central neuraxis. These areas not only control the activity of the preganglionic neurons but also participate in coordination of autonomic nervous system (ANS) activity with other homeostatic responses including respiration, arousal, and response to stress. The activity of neurons in these regions is regulated in a state-dependent manner during the sleep-wake cycle providing changes in cardiovascular and respiratory function. An important aspect of the coherence model, formally introduced as the “Heart Rhythm Coherence Hypothesis, is the inclusion of cardiovascular afferent neuronal inputs on sub-cortical and cortical structures, which can have significant influences on cognitive resources and emotions. Information is conveyed in the patterns of the HR which reflects current emotional states. The patterns of afferent neural input (coherence and incoherence) to the brain affect emotional experience, and modulate cortical function and self-regulatory capacity over macroscopic time scales.

Intentional activation of positive emotional states on physical, mental, and emotional health play an important role in increasing cardiac coherence and increasing self-regulatory capacity.

The coherence model postulates :

(1) The functional status of the underlying psychophysiological systems determines the range of one’s ability to adapt to challenges, self-regulate and engage in harmonious social relationships. Healthy physiological variability, feedback systems, and inhibition are key elements of the complex system for maintaining stability and capacity to appropriately respond to and adapt to changing environments and social demands.

(2) The oscillatory activity in the HR reflects the status of a network of flexible relationships among dynamic interconnected neural structures in the central and ANSs.

(3) State-specific emotions are reflected in the patterns of the HR independent of changes in the amount of HRV.

(4) Sub-cortical structures constantly compare information from internal and external sensory systems via a match/mismatch process that evaluates current inputs against past experience to appraise the environment for risk or comfort and safety.

(5) Physiological or cardiac coherence is reflected in a more ordered sine wave-like heart rhythm pattern associated with increased vagally mediated HRV, entrainment between respiratory, blood pressure and heart rhythms, and increased synchronization between various rhythms in the EEG and the cardiac cycle.

(6) Vagally mediated efferent HRV provides an index of the cognitive and emotional resources needed for efficient functioning in challenging environments in which delayed responding and behavioral inhibition are critical.

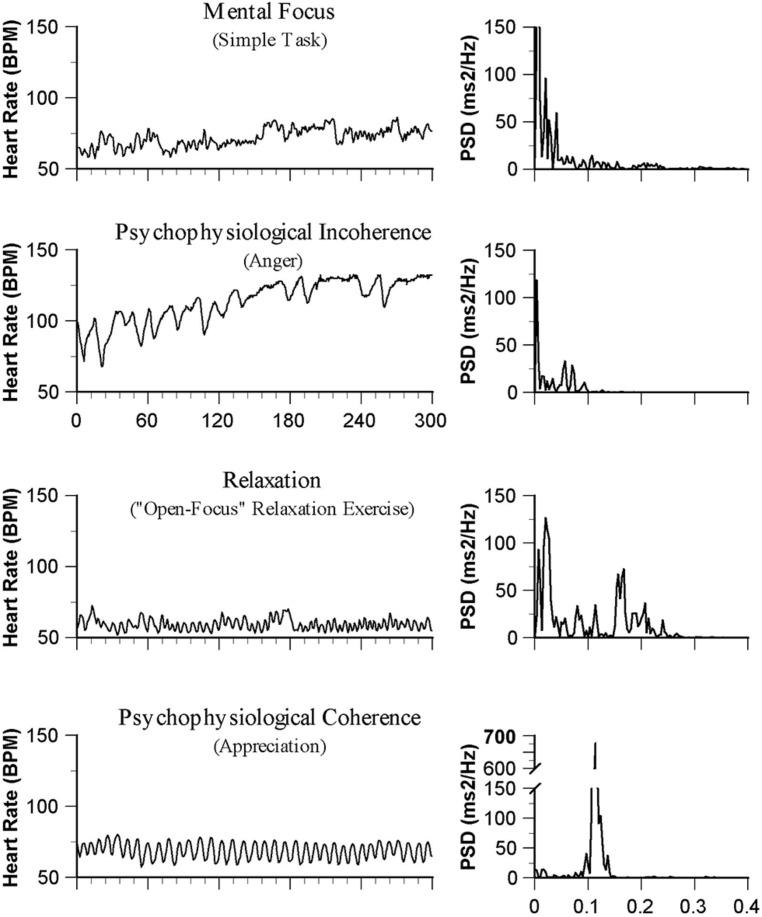
(7) Information is encoded in the time between intervals (action potentials, pulsatile release of hormones, etc.). The information contained in the inter-beat-intervals in the heart’s activity is communicated across multiple systems and helps synchronize the system as a whole.

(8) Patterns in the activity of cardiovascular afferent neuronal traffic can significantly influence cognitive performance, emotional experience, and self-regulatory capacity via inputs to the thalamus, amygdala, and other sub-cortical structures.

(9) Increased “rate of change” in cardiac sensory neurons (transducing BP, rhythm, etc.) during coherent states increases vagal afferent neuronal traffic which inhibits thalamic pain pathways at the level of the spinal cord.

(10) Self-induced positive emotions can shift the psychophysiological systems into a more globally coherent and harmonious order associated with improved performance and overall well-being.

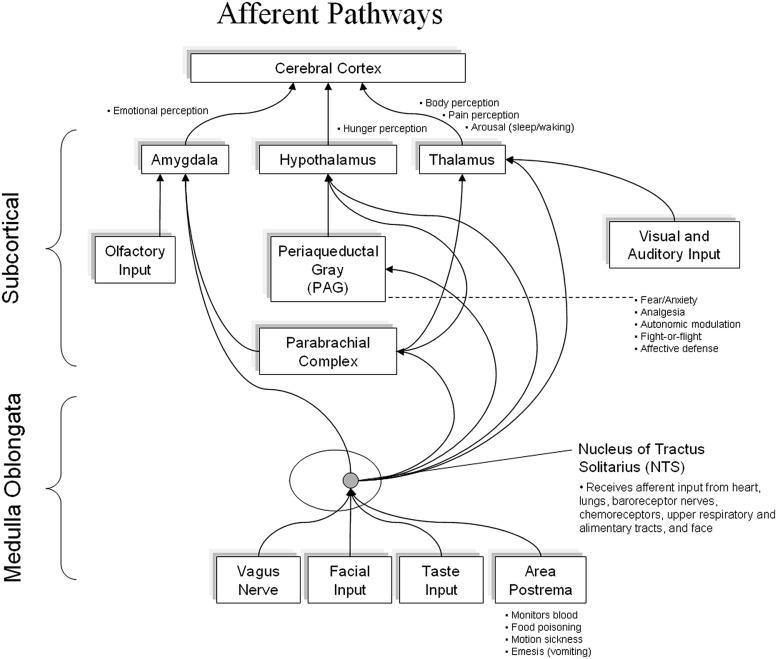
The association between the quality of emotional experience and the patterns reflected in HRV waveforms, includes coherence. The nature of the emotional experience is related to the level of coherence of the heart rhythm pattern. Positive emotions such as appreciation and compassion, are related to a coherent heart rhythm pattern; whereas, negative emotions are related to incoherent pattern. Positive emotions have a renewing physiological effect and negative emotions have a depleting physiological effect.



**Fig.84.Emotions and heart rhythm patterns.** The heart rate tachograms on the left side show patterns of the HRV waveforms observed in differing psychological states. The power spectral density (PSD) analysis of the HRV rhythms for each is shown on the left.

Physiological coherence is reflected in more ordered sine wave-like HRV patterns at a frequency of around 0.1 Hz (10 seconds rhythm). A coherent rhythm can be defined as “a relatively harmonic (sine wave-like) signal with a very narrow, high-amplitude peak in the LF region of the HRV power spectrum with no major peaks in the VLF or HF regions. Coherence is assessed by identifying the maximum peak in the 0.04–0.26 Hz range of the HRV power spectrum, calculating the integral in a window 0.03 Hz wide centered on the highest peak in that region, and then the total power of the entire spectrum. The coherence ratio is formulated as: [Peak Power/(Total Power - Peak Power)]” The coherence hypothesis suggests that the coherent flow of information within and between the physiological systems and processes in the central and ANS and body plays an important role in determining the quality of the feelings and emotions one experiences. Heart rate variability analysis, becomes an important tool that provides a window into the activity occurring between the heart and brain, as well as within regulatory centers in the brain. HRV is generated largely by the interaction between the heart and brain via the neural signals flowing through the afferent (ascending) and efferent (descending) neural pathways of the sympathetic and parasympathetic branches of the ANS.

Specific HRV variables are used to assess the beat-to-beat changes in heart rate associated with rhythms generated by different physiological mechanisms. The various HRV measures can be used to gain insights into the complex interactions between the central nervous system, the ANS and the heart. An appropriate level of physiological variability in the regulatory systems reflects an organism’s flexibility and ability to coherently adapt to stress and challenges. The overall amount of HRV related to age is best assessed over a 24 hour period with older people having lower levels than younger people. Low age-adjusted HRV, in the VLF and ULF bands, has been shown to be associated with increased health risk in a wide range of clinical conditions and all-cause mortality. HRV, especially the HF band, provides an index of psychological resiliency, behavioral flexibility and one’s capacity to adapt to changing social demands. The dynamic system of neural structures called the central autonomic network links cognitive performance with autonomic regulation and HRV. Resting levels of HRV are predictive of individual differences in performance on tasks requiring utilization of the prefrontal structures underlying executive functions.



**Fig.85.the major afferent inputs from the body to the Dorsal Vagal Complex.** Afferent pathways connect directly to the amygdala, hypothalamus, and thalamus, etc. There is emerging evidence of a direct connection from the NTS to the frontal cortex.

Patterns of complex afferent information is continuously sent to the brain (not just within the cardiac cycle) and is related to mechanical and chemical factors over time scales ranging from milliseconds to minutes. The heart rhythm coherence hypothesis “postulates that the pattern and degree of stability in the beat-to-beat changes in heart rate encodes information over macroscopic time scales which can influence cognitive performance and emotional experience” . During periods of increased cardiac coherence, there is an increased range of variability in both blood pressure and heart rate, which is detected as increases in the rate of change by the sensory neurons, resulting in increased firing rates which increases vagal afferent traffic. There is a more ordered pattern of activity. It has been demonstrated that vagal afferent nerve stimulation reduces migraine and cluster headaches and improves cognitive processing and memory in a wide range of clinical disorders such as epilepsy, obesity, depression, anxiety, autism, alcohol addiction, mood disorders, multiple sclerosis, and traumatic brain injury. Regular practice of HRV biofeedback results in lasting improvements in baroreflex gain independent of cardiovascular and respiratory effects, demonstrating neuroplasticity within the baroreflex system, in the intrinsic cardiac nervous system. Repeated sessions of heart coherence can reset the baroreflex system gain resulting in increased afferent nerve activity noninvasively.

Once a stable pattern is formed and established in memory, all sensory input to the brain from both the internal and external sensory systems is compared to the reference patterns and programs. When the current inputs match the baseline pattern, the brain recognizes them as familiar and experiences as comfortable and safe. The same process occurs even if the reference pattern is associated with anxiety, chaos, confusion, overwhelm, etc. Then it becomes comfortable because it is familiar. In order to maintain stability and feelings of safety and comfort there is need to maintain a match between the current experience or “reality” and the previously established neural programs. When a new experience or challenge is encountered, there can be a mismatch between the input patterns of the new experience and the lack of a familiar reference. Depending on the degree of mismatch, it requires either an internal adjustment (self-regulation) or an outward behavioral action to re-establish a match and feeling of comfort. When a mismatch is detected from either external or internal sensory systems, a change in activity in the central and ANS is produced. If the response is short-lived (one to three seconds), it is called arousal or an orienting reflex. If the stimulus or event is recurrent, the brain eventually adapts by updating the memories that serve as the reference. For example, people who live in a noisy city adapt to the ambient noise and eventually tune it out. Subsequent to this adaptation, it is only when they take a trip to the quiet countryside that the actual lack of noise seems strange and is quite noticeable. The mismatch between the familiar noisy background and the quiet setting leads to an arousal reaction that gets attention. It is this departure from the familiar that gives rise to a signaling function that creates the experience of an emotion, alerting to the current state of the mismatch.

In addition to the monitoring and control processes for regulation “in the here-and-now,” there are appraisal processes that determine the degree of consistency or inconsistency between a current situation and the projected future. Appraisals of future outcomes can be broadly divided into optimistic and pessimistic. Appraisals that project an inability to successfully deal with a situation may result in feelings of fear and anxiety as it could be the result of hypersensitivity to cues that resemble past traumatic experiences in the current situation. Alternately, an inaccurate appraisal can be due to an instability in the neural systems, or a lack of experience or insight of how to effectively deal with the projected future situation. The familiarity of the input can be sufficient to elicit a pessimistic response. This means we can easily get “stuck” in unhealthy emotional and behavioral patterns and that lasting improvements in emotional experience or behaviors cannot be sustained in the absence of establishing a new set point for the baseline.

If behavior change or improved affective states are desired, it is therefore critical to focus on strategies that help to establish a new internal reference. As we successfully navigate new situations or challenges, the positive experience updates our internal reference. In essence, we mature through this process as we learn to more effectively self-regulate our emotions and deal with new situations and challenges. It is through this process that we are able to develop a new, healthier internal baseline reference against which we match inputs so that our assessments of benign inputs are more accurate and result in a feeling of safety and comfort rather than threat and anxiety.If the neural systems that maintain the baseline reference patterns are unstable, unsettled emotions, and atypical reactions would be experienced. These neural systems can be destabilized by trauma, stress, anxiety or chemical stimulants. Therefore, it is clear that responding in healthy and effective ways to ongoing inner and outer demands and circumstances, such as daily life situations, depends to a great extent on the synchronization, sensitivity, and stability of our physiological systems . Neural inputs originate from numerous organs, and muscles, especially the face. The heart and cardiovascular system, have far more afferent inputs than other organs and is the primary source of consistent dynamic rhythms.

In addition to afferent nerve activity associated with mechanical information such as pressure and rate that occurs with each heartbeat, continuous dynamically changing patterns of afferent activity related to chemical information is sent to the brain and other systems in the body. In terms of emotional experience, there are afferent pathways to the amygdala via the Nucleus of Tractus and the activity in the central nucleus of the amygdala is synchronized to the cardiac cycle. Therefore, the afferent inputs from the cardiovascular system to the amygdala are important contributors in determining emotional experience and in establishing the set point to which the current inputs are compared.Through this feed-forward process, regulatory capacity is increased and new reference patterns are established, making it easier for people to maintain stability and self-directed control during daily activities, even during more challenging situations. Without a shift in the underlying baseline, it is exceedingly difficult to sustain behavioral change, placing people at risk of living their lives through the automatic filters of past familiar experience.

In social interactions, we also have set points or familiar habitual ways in which we perceive and respond. Consistent with the coherence model, social coherence is reflected in the harmonious quality of the network of relationships shared by individuals. In a socially coherent system, relationships are aligned in such a way as to allow for optimal collective function through efficient communication and shared energy resources. If our familiar social set points reflect a pattern of harmony and support, then optimal social functioning in our interactions leads to an experience of safety, comfort, and well-being. On the whole, social coherence rests on the ability of group members to remain attuned to the group and the ability of the group to be organized and regulated according to mutually agreed upon norms. Individuals at times experience incoherent feelings towards one another, such as preconceptions or judgments, which are unspoken and can result in disruptions in optimal social interactions through miscommunication or other damaging social dynamics. Generating unpleasant feelings and relational dynamics, physiological processes which have a direct bearing on the state of health are engaged. Individuals in incoherent social situations, including social chaos or isolation, are more susceptible to disease. The risks of isolation far exceed the combined risk for heart disease of smoking, obesity, lack of exercise, and excessive alcohol especially relevant for people suffering from trauma. Aside from the experience of inner turmoil, one of the major symptoms of trauma is social alienation that stems from depersonalization.

The protective value of close, meaningful relationships has become clear. Social Baseline Theory suggests that the primary environments to which humans are adapted to are other humans and the human brain implicitly assumes that it is embedded within a relatively predictable social network characterized by familiarity, joint attention, shared goals, and interdependence. When Social proximity, the “baseline” condition is maintained or reestablished, the brain is less vigilant for potential threats because it is familiar with the social environment. When we are in close proximity to our familiar social environment, and we have a match with our baseline state, we expend less emotional energy and expend self-regulating less energy. According to Social Baseline Theory, being alone is more effortful, because a variety of activities require more energy expenditures due to decreased load sharing and risk distribution. The fragmented psychological state that predominates in trauma, has become the new norm for alienation. Although isolation is innately stressful, a pattern of alienation under these circumstances can become habituated, such that social proximity may be experienced as a mismatch with the existing baseline and add to the perceived stress burden rather than alleviate the burden. This can place the individual in a downward spiral due to a repetitive self-sustaining feedback loop of separation from one of the very resources that has been demonstrated to facilitate healing. This separation may be exacerbated by cultural patterns of marginalization in societies where those with perceived disabilities are shunned, judged and even blamed, sometimes by caregivers themselves.

Experiences in early childhood with caregivers from attachment styles, that form the basis through which individuals approachlater relationships. Children who experience warm, supportive caregivers responsive to their needs develop a secure attachment style whereas children whose caregivers do not meet their needs would develop an insecure attachment style. These early lıfe experiences shape expevtations about future relationships. Social environments characterized by suppoortive realtionships regulate hypothalamic –pituitary activity, such that higher self-ratings of general health correspond with decreased hypothalamic activity during supportive hand holding in a threat task. Associations between an individual’s social support and health outcomes are mediated through the social regulation of hypothalamic sensitivity to threat, that depends on the individual and the individual’s response to social support. How an individual responds to social support in the face of threat has downstream health outcomes. The environment in which one develops influences an individual’s socal baseline.While individuals have a semi-permanent set point for their socal baselines, the immediate environment can cause fluctuations around these set points. Early environments affect individuals by influencing and updating priors, turning gene expression on and off, and ultimately determining one’s baseline. Aside from individual differences, the immediate context of social relationships has a powerful transient influence on the cognitive and neural processing and can temporally alter the set point of an individualS social baseline. Social affiliates are part of the immediate environment and one’s relationship with individuals and groups determine the quality of social resources one receives. Social resources are not static, but necessitate dyanmic responses to others.

Both threat and attachment figures are critical parts of the environment influencing how one allocates cognitive resources, for better or worse. In a strong, positive attachment figure, social relationships (i.e.social resources) buffer environmental threats, by chnaging how individuals perceive the threats. A trusted and interdependent conspecific can provide help in identifying and acquiring resources (e.g.food, shelter), vigilance for environmental threats and help in caring for offspring. These conspecifics share in the work for personal and genetic survival. This shared problem-solving, also known as load sharing, is a process by which individuals distribute effort in responding to environmental demands. In contrast to risk distribution, which mainly relies on an optimalnumber of conspecifics, the perceived energy required to achieve the goal is shared. There must be a foundation of shared goals, such as a desire to perpetuate one’s own genes, in order to motivate animals and humans alike to work together and share resources. This makes social relationship economically beneficial because they help achieve goals with shared cognitive resources.Social environments are malleable to the extent that social relationships are malleable. By changing how one individual perceives and interacts with apartner, positive and negative effects of threat perception and allocation of resources may change as well that constitute social baselines. Significant decreases in the neural activation and downstream regulation of neural threat response post-intervention when holding the hand of their romantic partner, particularly in brain regions associated with moderating negative affect.By improving the bond and interdependence between participant and romantic partner, social regulatory processes are improved by changing the way the brain encodes and responds to threats harnessing more social and cognitive resources provided by the romantic partner and maximizing the benefits of load sharing. Improvement in relationship quality with relational partners result in a higher social baseline, which translate into decreased threat perception when in proximity to the relational partner.

Social relationships can have negative effects on threat perception and resource allocation. The social environment contains a multitude of threatening situations that produce a physiological stress response. The coregulation or synchrony may reflect a homeostatic, regulatory process in which interdependent dyads, such as romantic partners, jointly pull each other toward a baseline level characterized by greater stability system. The interplay between a dyad’s physiological responses is associated with positive and negative individual and interpersonal functioning outcomes. Linkage in multiple systems is positively associated with indices of relationship connectedness, such as the amount of time spent together and the ability to identify the emotions of one’s partner. Synchrony in cortisol levels of marital partners is negatively associated with relationship satisfaction. Mothers’ stressful experiences are considered “contagious” to their infants, and members of close pairs, like mothers and infants, can reciprocally influence each other’s dynamic physiological reactivity. Dyadic interactions highlight more complex associations between one’s social environment and individual outcomes. For example, marital satisfaction may buffer spouses from their partners’ negative mood or stress state. Physiological linkage may confer benefits but also may put couples at risk if they become entrenched in patterns of conflict or stress. Overall, this evidence suggests that any effects should be considered in light of dynamic responses among one’s social environment, particularly between dyads. Well-being is socially attractive, whereas empathy supports close relationships.

Social baseline theory suggests that, as a social species, the baseline assumptions in physiological, cognitive, and neuropsychological processes are situated in social contexts. In an economy of actionframework, the baseline defaults to expect social resources and social support. There are not separate cognitive processes devoted specifically to the social environment, but cognitive processes may be automatically situated in social environments. Our social baselines have influences on our physiological, neural and cognitive processes, which are situated within our social baseline and even in environments, that are not inherently social but still provoking social effects.While being situated in a social environment is the default assumption, social baselines are not ubiquitous for everyone. There are individual differences in the extent to which we are socially situated and our socail baselines may indicate positive or negative experiences. For individuals with previously posiitve and supportive social and environmental experiences, their social baseline indicates that others would lower their cos of of acting in the world. The opposite is true for individuals with previously negative and unsupportive social and environmental experiences. For them, their social baseline indicates that others represent an added cost to acting in the environment. As individual differences alter the set point of social baselines, previous experiences and overall environments would create momentary fluctuations in social baselines. Our priors are not entirely fixed or static, and variability in our social environments or in dynamic responses to individuals would update our social baselines. High quality social relationships correspond with longer, happier, and healthier lives regardless of geography or culture.

*Social Baseline Theory* (SBT), a perspective that integrates the study of social relationships with principles of attachment, behavioral ecology, cognitive neuroscience, and perception science. According to SBT, the human brain assumes proximity to social resources that comprise the intrinsically social environment to which it is adapted. The human brain *expects* access to relationships characterized by interdependence, shared goals, and joint attention. Violations of this expectation increase cognitive and physiological effort as the brain perceives fewer available resources and prepares the body to either conserve or more heavily invest its own energy. This increase in cognitive and physiological effort is accompanied by distress, both acute and chronic, with all the negative sequelae for health and well being that implies. The first sense in which SBT refers to a social *baseline* has to do with the default and intrinsically social ecology the brain expects to function within. The likelihood of a behavior is optimized by calculating its metabolic cost against its perceived payoff, given prevailing personal bioenergetic resources. For example, human subjects tend to view hills as steeper, and distances as further away, if fatigued, sleepy, physically less fit, stressed, wearing a heavy backpack, or even simply in a low mood. It’s thought that these perceptual shifts regulate the motivation to walk up hills. Steeper hills require higher payoffs to justify the bioenergetic investment associated with climbing them, and diminished personal resources cause hills to look steeper.

Although the brain is highly responsive to perceived threat, even simple handholding can substantially attenuate threat those responses [https://pmc.ncbi.nlm.nih.gov/articles/PMC4375548/](https://pmc.ncbi.nlm.nih.gov/articles/PMC4375548/#R20) . These effects are potentiated by higher relationship quality, intimacy, and higher perceived mutuality. Individuals who experienced more maternal support behavior and higher neighborhood social capital in childhood are more receptive to social regulation as adults. A marital therapy designed to target the quality of attachment bonds increases receptivity to the social regulation of threat processing as well. Non-marital romantic breakups are associated with immediate and persistent decreases in self-concept clarity, and recovery of an independent sense of self prospectively predicts increased psychological wellbeing following a breakup.

SBT suggests that the human brain

1) assumes proximity to social relationships characterized by shared goals, interdependence, and trust; and

2) construes social relationships as bioenergetic resources, encoding others as part of the self. This allows humans to, in effect, outsource everything from probabilistic risk to threat vigilance, emotional responding, and a host of other demanding neural and behavioral activities. Proximity to social resources regulates our propensity for engaging in neural and behavioral work, with implications for how we think, act and feel. When social resources are absent, unreliable, or lost, our sense of self is diminished, along with both our objective and subjective efficacy.

Couple-level interventions are not only efficacious for treating relationship distress, but also for leveraging social resources in our understanding and treatment of, for example, borderline personality disorder, post traumatic stress disorder, obsessive-compulsive disorder, heart disease, the suffering associated with cancer and the emotional burden of caring for chronically ill child children. To survive and reproduce, organisms must take in more energy than they expend, a principle of behavioral ecology called economy of action.

Social baseline theory (SBT), a framework based on this principle, organizes links between social relationships, health, and well-being and maintains that the primary human ecology is a social ecology and predicts that humans find it easier and less energetically taxing to regulate emotion and act when in proximity to familiar and predictable others. Social Baseline Theory (SBT), a perspective that integrates the study of social relationships with principles of attachment, behavioral ecology, cognitive neuroscience, and perception science, and suggests that the human brain expects access to social relationships that mitigate risk and diminish the level of effort needed to meet a variety of goals. This is accomplished in part by incorporating relational partners into neural representations of the self. Decreased access to relational partners increases cognitive and physiological effort. Relationship disruptions entail re-defining the self as independent, which implies greater risk, increased effort, and diminished well being. The ungrafting of the self may mediate recovery from relationship loss. Reestablishing connectedness, whether inner or outer, such as in the case of trauma allows for reintegration. When individuals learn to sustain coherence while communicating with others, there is increased physiological linkage, and they become more sensitive to others so as to promote greater empathy and rapport, which allows for the process of heart felt connection to ocur.

The HeartMath self-regulation techniques and assistive technologies provide a systematic process for self-regulating thoughts, emotions and behaviors, and increasing physiological coherence to enable people to intervene in the moment they start to experience stress reactions or unproductive thoughts or emotions. Skill acquisition of the tools and techniques (Heart-Focused Breathing, Freeze Frame, Inner-Ease, Quick Coherence, Heart Lock-In, Prep, Shift and Reset, Getting In Sync, and Coherent Communication) are supported by heart rhythm coherence feedback technology. With practice, one is able to use one of the techniques to shift into a more coherent physiological state before, during and after challenging or adverse situations, thus optimizing mental clarity and emotional composure and stability. In such a state, most people are able to more quickly find their “center,” gain new perspectives, and counter ineffective and maladaptive thoughts, feelings, and behaviors.Effectively dealing with trauma and instating a new internal reference first involves increased self-awareness and recognizing triggers, reactions, and ongoing emotional undercurrents (fear, negative projection, insecurity, worry, etc.). Once one is more aware, the next step is learning how to consciously self-regulate and increasingly replace these feelings with more neutral or positive attitudes and perceptions.

The first step is called Heart-Focused Breathing, which includes putting one’s attention in the center of the chest (area of the heart) and imagining the breath is flowing in and out of that area while breathing a little slower and deeper than usual. Conscious regulation of one’s respiration at a 10 seconds rhythm (0.1 Hz) increases cardiac coherence and starts the process of shifting into a more coherent state. In challenging situations or after a strong emotion has been triggered, Heart-Focused Breathing is the step that most people can remember and find that it “helps take the intensity out” or “turn down the volume” of the reaction. As we have conscious control over breathing and can easily slow the rate and increase the depth of the breathing rhythm, we can take advantage of this physiological mechanism to modulate efferent vagal activity and thus the heart rhythm. This increases vagal afferent nerve traffic and increases the coherence (stability) in the patterns of vagal afferent nerve traffic which influences the neural systems involved in regulating sympathetic outflow, informing emotional experience, and synchronizing neural structures underlying cognitive processes. Rhythmic breathing methods are an effective way to increase heart rhythm coherence.For example, a study of Zen monks found that advanced monks tended to have coherent heart rhythms during their resting recording, while the ones that had been a monk for less than two years did not. Autogenic Meditation increase HRV coherence strongly correlated with EEG alpha activity if the coherence state is driven by a focus on breathing at a 10 seconds rhythm or a positive emotion. A study examining HRV while reciting rosary or bead prayers and yoga mantras found that a coherent rhythm was produced by rhythmically breathing patterns to a six cycles per minute and the rhythm of mantras and rosary prayers intentionally designed to induce coherent heart rhythms by individuals who had an intuitive understanding of the benefits of this rhythm.

In a study of the effects of five different types of prayer on HRV, it was found that all types of prayer elicited increased cardiac coherence; prayers of gratefulness and prayers that focused on heart felt love resulted in definitively higher coherence levels. It has been shown that tensing the large muscles in the legs in a rhythmical manner at a 10 seconds rhythm can induce a coherent heart rhythm. HRV coherence training is utilized to support self-regulation skill acquisition in educational, corporate, law enforcement and military settings. The majority of these systems, such as the emWavePro, or Inner Balance for iOS devices (HeartMath Inc), Relaxing Rhythms (Wild Divine), and Stress Resilience Training System (Ease Interactive), use a noninvasive earlobe or finger pulse sensor display the user’s heart rhythm, and provide feedback on their level of coherence and assess the degree of coherence in the user’s heart rhythms.The psychophysiological coherence model has informed the development of practical applications and approaches for increasing self-regulatory capacity and vagal tone in a wide range of populations, including individuals who have experienced trauma. Numerous studies have provided evidence that coherence training consisting of intentional activation of positive and calming emotions paired with HRV coherence feedback facilitates significant improvements in wellness and well-being indicators in a variety of populations.

The role of cardiac coherence in facilitating a resetting of adaptive response patterns through a shift in the physiological baseline reference to a healthier pattern appropriate for current contexts is highlighted as central to supporting the process of return to optimal function. While the experience of trauma is associated with a sense of fragmentation and loss of control that emerge from intrusive activations of the trauma stimulus, impairments in self-regulation, and difficulty returning to homeostasis, the practice of techniques that increase cardiac coherence is associated with an experience of intra and interpersonal synchronization, social harmony and wholeness. The process of re-patterning through intentional activation of positive emotions and generating an increasingly consistent state of psychophysiological coherence brings with it the possibility for addressing the primary defining components of the experience of trauma, allowing individuals to move out of the “stuck state” of dysregulation and fragmentation into a state of harmonious synchronized healthy function both at the individual and social levels.

Cardiac coherence, that is a state where heart rate variability (HRV) exhibits a unique oscillatory frequency with large oscillations, is achieved by controlling the breathing rate during the resonance frequency breathing to improve bottom-up vagal stimulations of the brain. This maneuver allows respiratory-driven vagal modulations of the heart rate to superimpose with sympathetic modulations occurring at 0.1 Hz, by maximizing autonomous power in heart-to-brain connections. These stimulations have been shown to improve vagal regulations, which results in benefits for both mental and organic health because the benefits are attributed to the exacerbated power in heart-to-brain bottom-up connections during practice, which is a condition that drives brain network remodeling. Improved functioning of the central network processes has critical effects on perceptual, cognitive and emotional regulation in patients, which are described, e.g., in terms of improved stress management, decreased PTSD symptoms and better attentional skills. In healthy people, the practice helped them to perform better in cognitive tasks and improved the management of stressful situations even among highly trained athletes engaged in important competitions.The heart–brain interplay has been described through a functional network linking the central nervous system (CNS) and the autonomous nervous system (ANS). Assessing the particular functioning of the so-called Central Autonomic Network can help researchers to grasp the main (dys)functions in both mental and organic health. The heart continuously sends bottom-up stimuli to the brain to have significant benefits for brain functions. The control of breathing to achieve so-called resonance frequency breathing is an efficient way to achieve cardiac coherence.

The short-range regulation of the heart rate by sympathetic and vagal branches of the autonomous nervous system (ANS) can be conceived as a two-oscillator system, affecting the basic heart rhythm imposed by the sinus node. The dominant influence on short-term HRV of the sympathetic drive results in a 0.1 Hz rhythm emerging from a central descending command and the baroreflex loop linked to vasomotor control of whole-body vascular beds (Mayer waves). Concurrently, modulation by the parasympathetic system is driven by the spontaneous 0.2–0.3 Hz breathing rate, which is reflected in similar 0.2–0.3 Hz oscillations in heart rate variability (HRV), known as Respiratory Sinus Arrhythmia (RSA). When one voluntary reduces their breathing rate to a rhythm approaching 0.1 Hz, these two oscillators are in resonance. This specific state is identified as cardiac coherence; HRV exhibits a smooth quasi-sinusoidal signal output at around 0.1 Hz with maximal magnitude, which is the desired effect. The best practice of cardiac coherence needs, one’s breathing rate to be guided, which could be associated with feedback information about the HRV sinusoidal signal to confirm perfect achievement, so-called HRV biofeedback.

Achieving cardiac coherence strengthens the heart–brain interplay through enhanced autonomous power (HRV oscillations), which has been shown to improve emotional and behavioral regulations, and health and well-being. Even simple paced breathing (without biofeedback) may offer sufficient conditions to achieve an increase in HRV and related benefits. Cardiac coherence is effective as long as resonance frequency breathing can be maintained. Successful breathing is reflected in the dominance of a single 0.1 Hz wave in HRV oscillations. Achieving cardiac coherence is of particular interest when one faces a difficult situation, wherein specifically cognitive, motivational and emotional manifestations are challenged.As neurophysiological bases of cardiac coherence are associated with regular and maximal oscillations in HRV when it is maintained for minutes, visuo-haptic guidance represents the most efficient practice, because the combination of visual and haptic sensory inputs may intensively rely on multisensory integration when it is compared to visual or haptic alone processing. The baroreflex loop and central command of the natural frequencies of people may be shifted a bit away from 0.1 Hz. Descending neural (central command) and ascending vascular oscillations may drive oscillations in HRV to be slightly above 0.1 Hz (0.1–0.14 Hz) and slightly below 0.1 Hz (0.06–0.1 Hz). The role of the central command may become predominant when multisensory integration is present, reducing the impact of baroreflex on resonance and making cardiac coherence more efficiently achievable through a specific heart–brain interplay.

When faced with a novel object, we explore it to understand its shape. This way we combine information coming from different senses, as touch, proprioception and vision, together with the motor information embedded in our motor execution plan. The exploration process provides a structure and constrains this rich flow of inputs, supporyting the formation of a unified percept and the memorization of the object features. Humans are very good at recognizing objects and inferring their properties by integrating information coming from multiple sensory channels and motor commands particularly for haptic perception., which depends on cutaneous and kinesthetic (proprioceptive) inputs, related to the position and the force applied by the limbs use dto touch , but also on the exploration startegies adopted e.g. the velocity of the exploratory movements or the way the object is handled.Recognizing an object through haptic exploration is a multimodal abılity, which requires short term memeory and a strategy to collect information. As a result, it enables to gather an approximate estimate of a wide range of object properties, as the weight, the size, the volume of the object at hand, together with the force needed to manipulate. Haptic exploration entails the acquisition of stimulus properties both in parallel, through the integration of inputs derived from the different effectors, as the fingers, the palm, the two hands; and in sequential manner, integrating information of different parts of the explored objects acquired over an extended period of time. The strategy adopted when touching or actively manipulating the object is crucial in determining the representation of the object as a whole.Through movement analysis and video annotation, six stereotyped movements, have been defined specific to determine a particular information about the object: lateral motion (texture), pressure (hardness), contour following (shape), unsupported holding (weight), enclosure (global shape), static contact (temperature).

Vision is an exploratory procedure, that offers an alternative way to explore the object, instead of or in conjunction with haptics In particular, the lateral occipital cortex (LOC), an object-selective region in the visual pathway, responds consistently also to haptic stimuli qualifying it as an area processing geometric shape information independently of the sensory modality used to acquire it. leading to a shared multisensory representation enabling cross-modal object recognition. The haptic modality is more appropriate for material properties as hardness, weight or texture, whereas for geometric, spatial properties the visual information seems to be richer and more economical. shape perception is characterized by two different dimensions: *shape encoding*, which includes shape features extraction, online construction and storage of mental representation and *shape matching*, which foresees evaluation of shape features in reference to a stored representation and decision-making. Vision is the dominant perceptual modality in humans. This is especially true for object recognition – a ubiquitous and highly important cognitive function – and particularly for recognizing objects based on their three-dimensional shape. In the absence of vision, accurate recognition of objects based on shape cues can be accomplished using haptic input alone. There is evidence that visual and haptic inputs are effectively combined to enhance recognition performance and that the haptic modality can successfully prime the visual modality and vice versa.

Human relationships influence their health and healing. Emerging concepts from quantum physics theory describe the energetic impact of human consciousness, communication, and the mind–body connection. Reality in quantum physics consists of a world where potential is as important as the actual, context influences the emergence of particles and the reality of consciousness goes beyond the biochemistry of neuronal interactions. Ancient indigenous and eastern approaches to health and spirituality have long adhered to the notion that human consciousness affects matter and events. Quantum theory examines the interplay between consciousness and material realities. Holism has an expanded meaning and holistic medicine includes many subtle consciousnesses and energy fields that interpenetrate and co-mingle to form the totality that is logical rhythmscalled the human being.

### The concept of coherence pertains to the homeostatic balance present in a healthy individual, representing harmonious interactions of the body׳s subsystems, external relationships, and interactions. Coherence implies a global order, structure, harmony, and alignment within and amongst systems. A commonly understood concept in physics is that coherent [electromagnetic fields](https://www.sciencedirect.com/topics/medicine-and-dentistry/electromagnetic-field) can form stable patterns.Coherence refers to the patterns of [biological rhythms](https://www.sciencedirect.com/topics/medicine-and-dentistry/biological-rhythm) that are in coupled states, resulting in synchronized oscillations. Many biocommunicative processes in biology rely on coherent oscillations to induce biochemical reactions. Quantum coherence involves a precise phase-correlated coupling between body [rhythms](https://www.sciencedirect.com/topics/medicine-and-dentistry/rhythm) such as the constant communication that occurs between the human heart and the [rest](https://www.sciencedirect.com/topics/medicine-and-dentistry/rest) of the body. Increased coherence in a single system, such as in the electromagnetic field of the heart, can [drive](https://www.sciencedirect.com/topics/medicine-and-dentistry/drive) coordination of related physiologic systems within the body. Research studying [heart rate variability](https://www.sciencedirect.com/topics/medicine-and-dentistry/heart-rate-variability) has revealed that an individual׳s emotional states can be directly correlated to cardiac electromagnetic coherence. Positive coping mechanisms and intention have been shown to increase cardiac coherence, whereas negative [emotions](https://www.sciencedirect.com/topics/medicine-and-dentistry/emotion) result in diminished coherence.

In agreement with self-determination theory (SDT), people differ in their reasons for engaging in their nutritional choices and these reasons correspond to the level of autonomy they experience in their life domain. When someone has more autonomous motivation orientation for a behaviour, they engage in that behaviour for the pleasure, interest and satisfaction derived from the behaviour itself; because it is consistent with other values in their self-system; and congruent with their values and goals (e.g. eating a plant-based diet because you view yourself as a healthy individual that is environmentally conscious). When someone has more controlling motivation orientation for a behaviour, he/she performs that behaviour because of self-imposed pressures such as guilt or anxiety or to achieve a reward or avoid a punishment (e.g. eating behaviours engaged in to avoid feeling ashamed for not eating healthy).People who have an autonomous orientation, versus a controlled orientation, assume greater responsibility for their actions because they have personally endorsed their course. Autonomously motivated behaviours are better maintained because they are either inherently enjoyable or are well internalized into the person’s sense of self . In relation to eating, autonomously motivated eating behaviours lead to better regulation of eating and weight management and more sustained regulation over time.

### Biological rhythms and their temporal organization are adaptive phenomena to periodic changes in environmental factors linked to the earth's rotation on its axis and around the sun. The rhythmic (as opposed to linear) expression of biological variables and the temporal organization of these rhythms represent an adaptation of organisms to the rhythmic changes in the external environment. Periodic oscillations (rhythms) have been documented in biological variables in a whole spectrum of living organisms (from unicellular to multicellular). The rhythms are governed by an active system capable of self-sustained oscillations (endogenous rhythms).[https://pmc.ncbi.nlm.nih.gov/articles/PMC3181781/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3181781/#ref1) The shape of rhythms and the temporal order are products of the interaction between endogenous (genetically controlled) oscillators and the phases (synchronizing, entraining) of external cues.

### External, desynchronization corresponds to a condition in which the phase relation of rhythms are changed by manipulating external synchronizers.  The speed (or duration) of adjustment varies among the variables for a given individual, as well among individuals for a given variable. This phenomenon is named transient desynchronization, since the changes in the temporal organization disappear as the subject becomes adjusted to the new local time. Transient desynchronization occurs in all subjects.In many diseases and syndromes, patients may be chronically deprived of night sleep. This may be because the patient's condition prevents sleep, rather than because of a sleep disorder per se. As even one or two sleep deprived nights may deeply alter rhythms in body temperature, heart rate, self-rated vigilance, and mood in healthy young subjects, this chronically induced sleep deprivation mimics whatever occurs in a night worker. In clinical practice, chronic deprivation of night sleep is rather frequent condition and, as in the case of nontolerant shift workers, it may lead to dyschronism. Using actigraphic recordings, it is possible to evaluate sleep deprivation related to various conditions, for example, sleep deprivation due to pain. Dyschronism may be involved in a rather large variety of circumstances, including chronic pain syndrome, nocturnal asthma, persisting anxiety and stress, prostate adenoma, or fibroma with nocturnal urinary voiding.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3181781/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3181781/#ref26) A collection of studies entitled direct mental interaction with living systems (DMILS) demonstrate that the significant and measurable effects on human intention influence the physiology of remote organisms. When the clinician maintains focused attention on the patient “intentionality and consciousness are united in the [energetic](https://www.sciencedirect.com/topics/medicine-and-dentistry/energy-transfer) field of emerging possibilities.”

From a healing perspective DMILS can be seen as a research paradigm of the very

mechanism underlying a distant healing process. The DMILS setup has some parallels to a

distant healing situation. There is a sender or a healer who tries to change the physical or

physiological state of a healee or receiver from a distance by intentional means. This is why

the DMILS paradigm is of major importance for any healing research that takes the possibility

of distant healing into account. The DMILS setup can provide us with an answer to the very

basic question as to whether it is in principle possible for an organism to react physiologically

in accordance with a remote intention. Or in other words, is there a mechanism independent

from any healing context that is responsible for effects of distant intention and that might also

be used in a distant healing situation. If one assumes that DMILS experiments and distant

healing rely on the same effect, then the DMILS laboratory is an excellent setting to study this

effect under controlled conditions. These investigations can address three areas, proof-,

process- and model-oriented research.

[Human relationships](https://www.sciencedirect.com/topics/medicine-and-dentistry/human-relation) influence our health and healing. In the clinical setting, divergent conceptual frameworks about healthcare can pose barriers to communication between patients and clinicians. Emerging concepts from quantum physics theory describe the [energetic](https://www.sciencedirect.com/topics/medicine-and-dentistry/energy-transfer) impact of human [consciousness](https://www.sciencedirect.com/topics/medicine-and-dentistry/consciousness), communication, and the mind–body connection. Reality in quantum physics consists of a world where [potential](https://www.sciencedirect.com/topics/nursing-and-health-professions/electric-potential) is as important as the actual, context influences the emergence of particles and the reality of [consciousness](https://www.sciencedirect.com/topics/medicine-and-dentistry/consciousness) goes beyond the biochemistry of neuronal interactions. Ancient [indigenous](https://www.sciencedirect.com/topics/medicine-and-dentistry/indigenous) and eastern approaches to health and spirituality have long adhered to the notion that human consciousness  [affect](https://www.sciencedirect.com/topics/medicine-and-dentistry/affect)s matter and events. Quantum theory  [examines](https://www.sciencedirect.com/topics/medicine-and-dentistry/examination) the interplay between consciousness and material realities. They predict that “holism will come to have an even more expanded meaning and [holistic medicine](https://www.sciencedirect.com/topics/medicine-and-dentistry/holistic-medicine) will be compelled to include the many subtle consciousnesses and energy fields that interpenetrate and co-mingle to form the totality that is called the human being.”

Coherence is also used to describe the coupling and the degree of synchronization between different oscillating systems. When two or more oscillatory systems operate at the same basic frequency, they can become either phase or frequency-locked which is called cross-coherence. In physiology, cross coherence occurs when two or more of the body’s oscillatory systems, such as respiration and heart rhythms, become entrained and operate at the same frequency. Global coherence does not mean that everyone or all the parts are doing the same things simultaneously. In complex global coherent systems, such as human beings, there is an incredible amount of activity at every level of magnification or scale that spans more than two thirds of the 73 known octaves of the electromagnetic spectrum. The Global Coherence Initiative (GCI) is a science-based, international effort that conducts research on interactions and interconnectivity between human consciousness and the Earth’s magnetic and energetic field environment, with the intention of promoting peace and harmony. This is measured by several interrelated initiatives, including the Global Coherence Monitoring System, the Global Tree Potential Monitoring System, the Global Coherence app, and citizen science projects. The newest addition to GCI is the Global Consciousness Project 2.0, which generates data from a globally distributed network of random number generators (RNGs), that are designed to produce unpredictable sequences of 0 and 1 bits, but they exhibit coherent behavior among each other when there is coherent attention or emotion across humanity. This has been established by the original Global Consciousness Project. GCP 2.0 is extending this research with a larger, more sensitive network of 4000 RNGs, advanced technology, and fundamental measurements of quantum random processes.

All biological systems on Earth are embedded in an environment of fluctuating magnetic fields that encompass a wide range of frequencies, and virtually every cell and circuit in biological systems can be affected.Numerous studies have found links between human physiological rhythms and collective behaviors which are synchronized with solar and geomagnetic activity. The Global Coherence Monitoring System (GCMS) is comprised of a network of six globally distributed ultra-sensitive magnetometers specifically designed to measure geomagnetic and resonant frequencies in Earth’s magnetic fields, such as Schumann resonances, Alfvén waves and other field-line resonances. The measured frequency ranges of the Earth’s magnetic fields overlap with the human physiological frequencies such as those of the human brain and cardiovascular systems. The GCMS network enables to better understand how people and animals are affected by the rhythms and resonant frequencies in Earth’s magnetic fields.

A new generation of scientists is showing that plants and trees are intelligent and aware, they process information, sleep, remember, and communicate with one another. They have at least 20 different types of senses that correspond to our five senses, but they also have additional senses that can do things such as measure humidity, detect gravity, vibrations and sense electromagnetic fields. Trees’ behaviors exhibit a coordinated activity and response across the whole organism that require signaling and communication systems which include long-distance electrical signals, specialized vascular tissues, and production of chemicals used by the brain and nervous systems in humans and animals. Researchers have also tracked the exchange of nutrients and chemical signals between trees through an invisible underground fungal network. The oldest trees, or “mother trees”, function as hubs and help nourish their offspring, until they’re tall enough to reach the light. Trees recognize their seedlings as kin and cooperate by trading nutrients across species. For example, when evergreen species have sugars to spare, they share them with deciduous species when they need them and vice versa. For the forest community, this cooperative and coordinated underground economy provides better over-all health, more total photosynthesis, and greater resilience in the face of disturbance that allows them to thrive collectively.

Traditional materialistic physics has historically perceived reality as a composition of elementary, solid building blocks existing in an empty space. Physical objects are no longer isolated entities but are seen as integral components within a holistic network of interconnections. Fields and relationships take center stage, blurring the lines between nonmaterial fields and the physical world. With compelling experimental proof of bio-electromagnetic fields, or "biofields," new biophysical models have emerged, depicting human existence as multidimensional. These models encompass various levels of nonmaterial field-related aspects of our thoughts, emotions, and intuitions. The ease and fluidity of social interactions are profoundly influenced by the natural establishment of spontaneous synchronization or connection between individuals. During meaningful conversations, a subtle interplay emerges, where people start to harmonize their physical movements, body postures, vocal tones, speaking rhythms, and the duration of pauses between their responses. Moreover, significant aspects of their physiology can become interconnected and synchronized. In group dynamics, increased physiological synchronization has been demonstrated to boost conformity, fostercooperation and trust, and fortify the social bonds among group members. In order for physiological activity to synchronize among separate individuals, some type of meaningful signal (electromagnetic, light, tactile, sound, or quantum level information) must transport information between them.

The convergence of independent lines of evidence provides strong support for the existence of a global information field that connects all living systems and consciousness. Every cell in our bodies is bathed in an external and internal environment of fluctuating invisible magnetic forces that can affect virtually every cell and circuit in biological systems. Numerous physiological rhythms in humans and global collective behaviors are not only synchronized with solar and geomagnetic activity, but disruptions in these fields can create adverse effects on human health and behavior.The mechanism for explaining how solar and geomagnetic influences affect human health and behavior are a coupling between the human nervous system and resonating geomagnetic frequencies, called Schumann resonances, which occur in the earth-ionosphere resonant cavity and Alfvén waves. It is well established that these resonant frequencies directly overlap with those of the human brain and cardiovascular system. If all living systems are interconnected and communicate with each other via biological, electromagnetic, and nonlocal fields, humans can work together in a co-creative relationship to consciously increase the coherence in the global field environment, which distributes this information to all living systems within the field.

GCI hypothesizes that when enough individuals and social groups increase their coherence baseline and global consciousness and utilize the increased coherence to intentionally create a more coherent standing reference wave in the global field. This can be achieved when an increasing number of people move towards more balanced and self-regulated emotions and responses. This facilitates cooperation and collaboration in innovative problem solving and intuitive discernment for addressing society's significant social, environmental, and economic problems. As more individuals stabilize the global field and families, workplaces, and communities move to increased social coherence, it leads to increased global coherence. This will be indicated by countries adopting a more coherent planetary view so that social and economic oppression, warfare, cultural intolerance, crime, and disregard for the environment can be addressed meaningfully and successfully.One of the scientific understandings that emerged from the last century is that the universe is wholly and enduringly coherent.  The phenomenon of coherence is well known. It indicates a quasi-instant connection among the parts or elements of things, whether an atom, an organism, or a galaxy. This kind of coherence is observed in fields as diverse as quantum physics, biology, cosmology, and brain and consciousness research. The new picture that has emerged is that all living systems are interconnected at a deep fundamental level and communicate with one another via biological fields and nonlocal mechanisms. It has become increasingly clear that invisible magnetic influences emanating from the sun and earth profoundly affect life on earth from birth to death and solar and geo-magnetic cycles not only correlate with human health indicators, but also with such major societal conflicts as violence, crime, terrorism, and war.

The Institute of HeartMath (IHM) has identified a psychophysiological state that is the underpinning of optimal function termed heart coherence. This has led to the development of practical techniques, tools, and technologies that help empower people to better manage stress, increase performance, and connect with a deeper intelligence and intuitive awareness. Numerous studies have shown that learning how to shift into this psychophysiological state quickly improves cognitive performance, focus and effectiveness, self-responsibility, and social cohesion. Although people are able to achieve and increase heart coherence in a variety of ways—breathing exercises, heart-focused meditation, and listening to uplifting music among others—studies have shown one of the quickest and most effective ways is through emotional self-regulation and generating positive emotions, such as compassion, love, appreciation, and care.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/#B13)At the individual level, a person's level of heart coherence can be assessed by monitoring the rhythmic patterns that are reflected in their heart-rate variability (HRV), the beat-to-beat changes in heart rate. Positive emotions such as love, appreciation, and compassion generate a heart-rhythm pattern that is more ordered and coherent, whereas negative emotions such as anxiety, anger, and fear generate a disordered, incoherent heart-rhythm pattern.

Ongoing feelings of impatience, frustration, irritation, worry, or blame throw our inner rhythms out of sync and have a negative carryover effect on our hormonal and nervous systems. Studies have found that the combination of emotional self-regulation techniques with heart rhythm coherence monitoring technology (emWave) has proven to be highly successful for reducing stress, anxiety, anger, chronic pain, fatigue, and burnout, as well as many other stress-related conditions. By practicing the heart-focused self-regulation techniques and using heart rhythm coherence monitoring devices, people can learn how to quickly reset their emotions and shift into a balanced inner rhythm that the rest of the body will harmonize to, allowing more ease and flow. The inner rhythm and state of heart coherence is what many meditation techniques are trying to achieve. The emWave helps to slow the mental/emotional vibratory rate and increase the heart coherence baseline (ie, when the heart, brain and nervous system operate more in sync and with increased efficiency). As a person's heart coherence baseline increases, he or she will experience more mental clarity, creativity, and focus during the day. The carryover effect helps users to be more conscious and intuitive at choice points, allowing them to choose their actions and reactions rather than automatically responding in the same old stress-producing behavior patterns.IHM, a nonprofit research and education organization, established the Global Coherence Initiative (GCI) as a science-based, co-creative initiative to unite people in heart-focused care and intention and to facilitate the shift in global consciousness from instability and discord to balance, cooperation, and enduring peace. A primary goal of GCI is to determine the effects of collective emotional responses that are reflected in the earth's energetic fields (ionosphere and geomagnetic field).

The first overarching hypothesis of GCI is that all living systems are interconnected at an energetic level and communicate with one another via biological fields, including nonlocal fields, when certain conditions are met. From this general hypothesis, the second overarching hypothesis is that not only are humans affected by planetary energetic fields, but conversely the earth's energetic systems are also influenced by and act as a carrier wave for collective human emotions and consciousness (positively or negatively). Much of the planetary “information field environment” is made up of the collective consciousness of the inhabitants. The third hypothesis is that large numbers of people intentionally generating heart-coherent positive emotional states of care, compassion, love, and appreciation will generate a coherent standing wave that can help offset present and future planetary-wide standing waves of stress, fear, discord, and incoherence. Human emotions and consciousness interact with and encode information in planetary energetic fields, including the geomagnetic field, thereby communicating information between people at a subconscious level, which in effect, links all living systems and gives rise to a form of collective consciousness. Thus, a feedback loop exists between all human beings and the earth's energetic systems.

When coherently aligned individuals are intentionally creating physiologically coherent waves, they encode information in the planetary scale energetic fields, which act as a carrier wave, positively impacting all living systems contained within the field environment and the collective consciousness. This creates a mutually beneficial feedback loop between human beings and the earth's energetic systems. The intention of GCI is to be a catalyst that will instigate, facilitate, and support the maintenance of an upward spiral of this feedback loop for the mutual benefit of human beings and the planet we call home. The current focus of the initiative is the deployment of the Global Coherence Monitoring System to measure and explore fluctuations and resonances in the earth's magnetic field and in the earth-ionosphere resonant cavity in order to

1. conduct research on the mechanisms of how the earth's fields affect human mental and emotional processes, health outcomes, and collective human behavior;
2. explore how collective human emotional states and intentions are reflected in the earth's electromagnetic and energetic fields;
3. determine if changes in the earth's energetic fields occur prior to natural catastrophes such as earthquakes, volcanic eruptions, floods, storms, and human-made events such as social upheaval, unrest, and terrorist attacks; and
4. monitor global events to determine where GCI members' collective heart-coherent prayers, meditations, affirmations, and intentions can be directed.

It is anticipated that by investigating how individual and collective emotional energy affects the earth's fields that, to facilitate a growing awareness of humanity's interdependence with the earth and with each other. Every cell in our bodies is bathed in an external and internal environment of fluctuating invisible magnetic forces.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/#B9) It has become increasingly apparent that fluctuations in magnetic fields can affect virtually every circuit in biological systems to a greater or lesser degree, depending on the particular biological system and the properties of the magnetic fluctuations. Human physiological rhythms and global behaviors are not only synchronized with solar and geomagnetic activity, but disruptions in these fields can create adverse effects on human health and behavior. Changes in geomagnetic activity are correlated with hospital admissions and mortality from heart attacks and strokes, as well as numerous other adverse health effects such as depression, fatigue, mental confusion, and number of traffic accidents that occur. Important biological processes take place such as altered blood pressure, heart rate, HRV, melatonin levels, increased occurrence of cancer, balance of hormonal system, reproductive system, cardiac and neurological disease, and death. Changes in geomagnetic conditions strongly affect the rhythms of the heart.

Historically, many cultures believed that their collective behavior could be influenced by the sun and other external cycles and influences. On a larger societal scale, increased violence, crime rate, social unrest, revolutions, and frequency of terrorist attacks have been linked to the solar cycle and the resulting disturbances in the geomagnetic field. The first scientific evidence of this belief was provided by Alexander Tchijevsky, a Russian scientist who noticed that more severe battles during World War I occurred during peak sunspot periods.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/#B31) He conducted a thorough study of global human history and constructed an index of Mass Human Excitability dating back to 1749, which then compared to the solar cycles over the same time period until 1926.

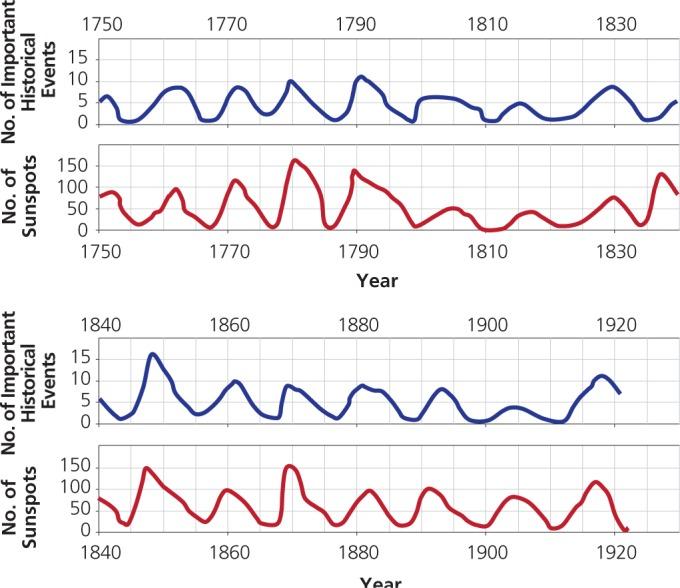


Fig.86.Tchijevsky's original data. The blue line plots the yearly number of important political and social events such as the start of a war, social revolutions, etc, while the red line plots the solar activity as indicated by the number of sunspots from 1749 to 1922. The histories of 72 countries were compiled, and it was found that 80% of the most significant events occurred during the solar maximum, which correlates with highest periods of geomagnetic activity.

The mechanism for explaining how solar and geomagnetic influences affect human behavior and health are a coupling between the human nervous system and the resonant frequencies generated by geomagnetic field line resonances and the globally propagating magnetic waves called Schumann resonances (SR) that occur in the earth-ionosphere resonant cavity. It is well established that the earth and ionosphere generate a symphony of resonant frequencies that directly overlap with those of the human brain and cardiovascular system. The central hypothesis is that changes in these resonances can influence the function of the human autonomic nervous system, brain, and cardiovascular system.The evidence that human health and behaviors are globally influenced by geomagnetic activity is quite strong and convincing. There is experimental evidence that human bioemotional energy can have a subtle but significant (scientifically measurable) nonlocal effect on people, events, and organic matter. It is becoming clear that a bioelectromagnetic field such as the ones radiated by each human heart and brain can affect other individuals and the “global information field environment.”

When an individual is in a state of heart coherence, the heart radiates a more coherent electromagnetic signal into the environment that can be detected by nearby animals or the nervous systems of other people.[https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/](https://pmc.ncbi.nlm.nih.gov/articles/PMC3833489/#B35) Of all the organs, the heart generates the largest rhythmic electromagnetic field, one that is approximately 100 times stronger than that produced by the brain. This field can be detected several feet from the body with sensitive magnetometers. This magnetic field provides a plausible mechanism for how we can “feel” or sense another person's presence and emotional state independent of body language or other factors.There is a direct relationship between the heart rhythm patterns and the spectral information encoded in the frequency spectra of the magnetic field radiated by the heart. Information about a person's emotional state is encoded in the heart's magnetic field, which is communicated throughout the body and into the external environment. People trained in achieving high states of heart coherence could facilitate coherence in other people in close proximity. The coherence of untrained participants are facilitated by others who are in a coherent state. There is a substantial body of evidence indicating an interaction between human emotions and global fields when large numbers of people have similar emotional responses to events or organized global peace meditations.

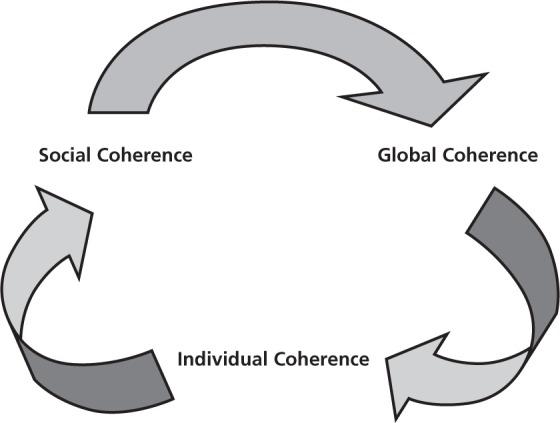


Fig.87.Global Coherence Initiative theory of change.

Every individual contributes to the global field environment, and each person's attitudes, intentions, and emotional experiences count. This is empowering for many individuals who feel overwhelmed by the current negative predictions and conflicts on the planet. They come to realize that their actions can make a difference by increasing their own coherence.The personal benefits of better emotional self-regulation, enhanced well-being, more self-responsibility, better health, and improved relationships people experience are powerful motivators that reinforce the process for the individual. As more and more individuals become increasingly self-regulated and grow in conscious awareness, the increased individual coherence in turn increases social coherence, which is reflected in increased cooperation and effective co-creative initiatives for the benefit of society and the planet.A shift in consciousness is necessary in order for a significant shift to occur that enables new levels of cooperation and collaboration in innovative problem solving and intuitive discernment for addressing our social, environmental, and economic problems. In time, global coherence will be indicated by more communities, states, and countries adopting a more coherent planetary view.GCI is a science-based, co-creative project to unite people in heart-focused care and intention and facilitate the shift in global consciousness from instability and discord to balance, cooperation, and enduring peace. A primary goal is further study the interconnectedness between humanity and the earth's energetic systems. There is a substantial body of evidence that humans are affected by planetary energetic fields. GCI hypothesizes that human emotions and consciousness interact with and encode information in planetary energetic fields, including the geomagnetic field, communicating information between people at a subconscious level, which links all living systems and gives rise to a form of collective consciousness. A feedback loop exists among all human beings and the earth's energetic systems.

When enough individuals and social groups increase their coherence and utilize that increased coherence to intentionally create a more coherent standing reference wave in the global field, it will help increase the global consciousness. This can be achieved when an increasing ratio of people move towards more balanced and self-regulated emotions and responses. This can facilitate cooperation and collaboration in innovative problem solving and intuitive discernment for addressing society's significant social, environmental, and economic problems. In time, as more individuals stabilize the global field and families, workplaces, and communities move to increased social coherence, it will lead to increased global coherence. This will be indicated by countries adopting a more coherent planetary view so that social and economic oppression, warfare, cultural intolerance, crime, and disregard for the environment can be addressed meaningfully and successfully.In order to conduct research on the mechanisms of how the earth's fields affect human mental and emotional processes, health outcomes, and collective human behavior and explore how collective human emotions and intentions may be reflected in the earth's electromagnetic and energetic fields, a global network of ultrasensitive magnetic field detectors specifically designed to measure the magnetic resonances in the earth/ionosphere cavity and resonances and earth's geomagnetic field lines resonances are being installed at strategic locations around the earth.The monitoring system and the research studies are bringing people together for the purposes of improving their lives and creating a new more coherent standing wave in the planetary field environment. GCI's primary goal, which is to motivate more people to work together in a more coherent and collaborative manner to increase harmony in the collective consciousness to alleviate social conflicts.

In living systems, there are micro-level systems, molecular machines, protons and electrons, organs and glands each functioning autonomously, doing very different things at different rates, all working together in a complex harmonious coordinated and synchronized manner. The brain rhythms operate over a wide range of frequencies, exhibiting various degrees of synchronized activity with the heart, which has much slower rhythms than the brain. When heart rate increases, the activity and amplitude of the brain waves increase. Coherent heart rhythm increases heart-brain synchronization. Auto-coherence describes coherent activity within a single system that exhibits sine wave like oscillations. More stable the frequency, amplitude and shape, higher is the degree of coherence. Increased coherence in a system coupled to other systems, push other systems into increased synchronization for more efficient function. Frequency pulling and entrainment are seen between heart and brain frequencies, respiratory and blood pressure and craniosacral rhytms and SKIN electrical potentials. So the coherent state is correlated with well-being, and cognitive, social and physical performance improvements.

Physiological coherence describes the degree of order, harmony and stability in various rhythmic activities within living systems over any given time period. This harmonious order signifies a coherent system, whose efficient or optimal function is directly related to the ease and flow in life processes. By contrast, an erratic, discordant pattern of activity denotes an incoherent system whose function reflects stress and inefficient utilization of energy in life processes. Positive emotions such as appreciation and compassion, as opposed to negative emotions such as anxiety, anger, and fear, are reflected in heart rhythm pattern. Emotions modify the activity of the body’s physiological systems, and beyond their pleasant subjective feeling, heart-felt positive emotions and attitudes provide a number of benefits that enhance physiological, psychological, and social functioning. Naturally emerging coherence increases harmony in the energetic system (referring to the functions that cannot be directly measured, touched or seen) with the activation of heartfelt positive emotions such as appreciation, compassion, care and love. This increased coherence and alignment facilitate the body’s natural regenerative processes. Physiological coherence, referred as heart or cardiac coherence or resonance is a functional mode, measured by heart rate variability (HRV) analysis where a person’s heart rhythm pattern becomes more sine-wave like ordered at a frequency of around 0.1 Hz (10 seconds). Another aspect of coherence mode is the phenomenon of resonance, that occurs in an oscillatory system when there is a large sudden increase in amplitude at a specific frequency. The frequency of amplitude increase is defined as the resonance frequency of the system. The resonance frequency of the human cardiovascular system is determined by the feedback loops between the heart and the brain .

In humans and in many animals, the resonance frequency of the system is approximately 0.1 Hz. Coherence and resonance are characteristic of natural physiological state associated with heart-felt positive emotions. Physiological coherence embraces several related phenomena –autocoherence, cross-coherence, synchronization, and resonance – all of which are associated with increased order, efficiency, and harmony in functioning of the body’s systems. When one is in a coherent state, it reflects increased synchronization and resonance in higher-level brain systems. Psychologically, coherence reflects increased emotional and perceptual stability and alignment among the physical, cognitive, and emotional systems. Coherence and resilience are closely related to physiological and psychological processes, that are states rather than traits varying over time as demands, circumstances, and level of maturity change.

Physical resilience is reflected in physical flexibility, endurance and strenght while emotional resilience is one’s ability to selfregulate the degree of emotional flexibility, positive emotions and relationships. Mental resilience is reflected in attention span, mental flexibility, and ability to integrate multiple points of optimistic world view. Physical resilience, which is defined as one’s ability to withstand or recover from functional decline following acute and/or chronic health stressors[https://pmc.ncbi.nlm.nih.gov/articles/PMC6157007/](https://pmc.ncbi.nlm.nih.gov/articles/PMC6157007/#R1), is a construct that resonates with older patients and caregivers. Successful aging depends on a person’s response to the inevitability of late-life stressors. Physical resilience is distinct from the construct of psychological resilience. Whereas psychological resilience refers to a person’s ability to adapt well in the face of adversity, trauma, tragedy, threats or significant sources of stress, physical resilience focuses on the maintenance or recovery of function after biomedical or pathological challenges[https://pmc.ncbi.nlm.nih.gov/articles/PMC6157007/](https://pmc.ncbi.nlm.nih.gov/articles/PMC6157007/#R6). Physical resilience reflects adaptive physiological responses at the level of organs, cells, and molecules (e.g., musculoskeletal, neurological, immunological processes) that support homeostasis under changing conditions[https://pmc.ncbi.nlm.nih.gov/articles/PMC6157007/](https://pmc.ncbi.nlm.nih.gov/articles/PMC6157007/#R6). Psychological resilience, that is the ability to cope successfully with adversity occurring stressful periods, which may otherwise trigger mental illness and to adapt to stressful life events, varies widely from person to person and depends on environmental as well as personal factors:

([1](https://www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2020.608588/full#B1)) It refers to positive adaptation or the ability to maintain mental and physical health despite participating in stressful situations

([2](https://www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2020.608588/full#B2)). Mental health is more than the absence of mental illness

([3](https://www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2020.608588/full#B3)). Although resilience is considered a “trait” in psychology, it may present itself in varying degrees across different life domains, times and environments.

Models of psychological resilience highlight the combination of physiological, neurobehavioral and psychological factors as significant contributors to protecting resilience. Psychological factors, such as optimism, self-efficacy , high intelligence, and the use of adaptive emotional regulation strategies, have all been shown to positively contribute to resilience. Gender differences in resilience and psychological distress have also been documented, where male participants show greater psychological resilience than females, and females are more vulnerable to psychological distress than males. Inhibitory control (IC), the executive function component which underlies one's ability to maintain goal-directed behavior while ignoring irrelevant information has been suggested as a key component underlying psychological resilience. Difficulties in the ability to inhibit actions may impair the achievement of motor, cognitive, or social-emotional goals. , IC is related to one's behavioral pattern, and is crucial for efficient functioning in varied situations of daily life. Higher demand for inhibitory control is associated with better resilience to potential interruption.

At the neural level, resilience has been shown to be associated with functional connectivity between regions which are involved in inhibitory control, emotional flexibility and coping. If psychological resilience is not effective enough in the face of adversity, it can lead to the other extreme of mental illness. Reduced or impaired IC ability over negative information, especially in the context of processing emotional information heighten emotional reactivity and increase vulnerability to depression and have been hypothesized as the cause for attention biases which lead to ruminative responses and negative mood states in depression as well as to the inability to inhibit triggers of trauma related to PTSD. Psychological distress, a mental state of emotional suffering characterized by depression and anxiety symptoms , has also been shown to be related to impaired IC ability. Intact IC may contribute to psychological resilience and the ability to cope with adversity, while impaired IC is a potential risk factor for the onset or the aggravation of mental disorders and mental distress.While low reserve in any biological system may render a person more frail (i.e. vulnerable to stress), an intriguing possibility is that certain biological processes are particularly key to resilience. Recovery of homeostasis under stressful conditions may rely on factors such as metabolomics, mechanisms that protect and repair DNA and proteins, and precise regulation of stem cells. Physical resilience is the ability to recover from an external perturbation, an integral aspect of functional adaptability and healthy behavior. Techniques that quantify behavior over multiple time scales offer a solution to quantifying resilience. As people age, they tend to lose functional adaptability and resilience. The human body is known to exhibit fractal like structure, meaning it is irregular, but exhibits self-similarity. The overall shape or pattern of a fractal structure can be broken down into smaller components, which are statistically similar to the whole structure, regardless of the scale at which they are observed.

This fractal structure provides redundancy to the human body and its subsystems, that provides the human body with a set of possible states as opposed to a single state. This redundancy, which exists across different physical scales of organization in the human body (e.g. whole-body scale, organ scale, tissue scale), gives rise to long-range correlations in physiological and biomechanical time-series data.[https://www.nature.com/articles/s41598-025-92746-7](https://www.nature.com/articles/s41598-025-92746-7#ref-CR17)Being able to access many different system states is beneficial in the sense that it allows the human body to adapt to varying demands, and to switch to a different state in the case that the current one becomes disadvantageous or inaccessible[https://www.nature.com/articles/s41598-025-92746-7](https://www.nature.com/articles/s41598-025-92746-7#ref-CR22). Long-range correlations are measurable through nonlinear analysis techniques, such as the detrended fluctuation analysis (DFA)[https://www.nature.com/articles/s41598-025-92746-7](https://www.nature.com/articles/s41598-025-92746-7#ref-CR23) In a persistent signal, increases or decrease in the values at any specific time scale are followed by increases or decreases at other time scales, respectively. This persistence is indicative of self-similarity in time, which is accompanied by self-similarity in the system’s physical structure[https://www.nature.com/articles/s41598-025-92746-7](https://www.nature.com/articles/s41598-025-92746-7#ref-CR28). Measuring a system’s persistence in time is an indirect way of measuring its physical redundancy and fractal structure, with which the set of possible system states can be inferred[https://www.nature.com/articles/s41598-025-92746-7](https://www.nature.com/articles/s41598-025-92746-7#ref-CR30).The baseline state should be defined as a homeostatic system, or a fixed-point attractor. In the classical interpretation of both homeostasis and fixed-point attractors, it is assumed that there is a single state in which the system fluctuates around or moves toward. Biological systems tend to fluctuate within acceptable limits (i.e. homeokinesis), as opposed to fluctuating around a single state (i.e. homeostasis). Instead of simply pushing the system into a different state, a perturbation diminishes the set of possible states that the system has access to, lowering its dimensionality in phase space. The actual state, is necessarily dependent upon the set of probable states. Recovery to baseline means recovering the set of possible states, following a perturbation that resulted in the loss of possible states. An adequate measure of physical resilience includes time to recovery or completeness of recovery, where recovery means the system has regained access to a set of system states that is equivalent to (not identical to) the set of system states that was present at baseline.

Spiritual resilience is associated with commitment to core values, intuition, and tolerance of others’ values and beliefs. In a coherent state, increased physiological efficiency and alignment of mental and emotional systems accumulate resilience across all the energetic domains. Having high level of resilience is important not only for recoupling from challenging situations, but preventing unnecessary stress reactions (frustration, impatience, anxiety).Resilience, that is universally understood as a form of adaptation, or flourishing in the face of adversity, is achieved through the utilization of various internal and external resources. The importance of resiliency, that stems from evidence that, ‘As individual grow older, greater resilience may lead to a more meaningful and satisfying old age’, allows for an opportunity to understand and identify coping tools and associated characteristics. More specifically, coping, a key component of the resilience process, is a universal human activity and experience for opportunity and adversity.

The importance of understanding spirituality as a source of resilience extends the moral guidance or belief system. Religion and spirituality are alternatives to medical treatment gaps, or may complement existing treatments. Religiousness, belief systems, and spirituality sources have been associated to increased levels of happiness, well-being, and life satisfaction strengthening resilience. These beliefs are particularly useful because they are not lost or impaired with physical disability, unlike many other coping resources that are dependent on health (e.g. hobbies, social relationships, or job). Finding meaning in life, reframing loss narratives, and building community are some of the ways in which spirituality reinforces resilience and supports individuals as they age. Spirituality is comprised of cognitive, affective, and relational elements that work in tandem to support an individual’s ability to handle the challenges of later life, such as illness and loss, as well as to enhance the experience of aging. The term well-being is used interchangeably, whether it is denoting one’s health or their quality of life. As individuals age, spiritual well-being has been reported to become more significant as a source of strength. Benefits of maintaining a spiritual well-being include positive health outcomes, discovering meaning and purpose, and facilitating coping mechanisms. Spiritual resilience is the ability to sustain one’s sense of self and purpose through a set of beliefs, principles or values while encountering adversity, stress, and trauma by using internal and external spiritual resources.



Fig.83.Domains of Spirituality in Relation to Resilience

Psychological resilience can be expressed as the ability of individuals to adapt and maintain their resilience healthily in the face of adverse events such as difficulties in life, stressors, trauma, or change including easy recovery from negative situations. People with psychological resilience show the ability to easily recover, adapt and overcome difficult life situations they have experienced. People with high resilience cope more successfully with various kinds of stressful life events they encounter, while people who are unsuccessful in coping with them can overcome the problems they encounter more easily by improving their resilience levels. Psychological resilience is characterized both as a personality trait and as a skill acquired as a result of a developmental process. Resilience is united in three main common themes. The first is any risk or difficulty, the second is adaptation and coping, and the third is the protective factor. Psychological resilience, a phenomenon that includes the interaction of protective factors, contributesw to a healthy adaptation process with existing risk factors. The ability of individuals to cope with difficulties, manage stress, maintain emotional balance and adapt to life’s challenges is critical for mental health. Stressful events are included in the epidemiology of psychopathologies. People with high psychological resilience show emotional resilience and adapt to difficulties. Psychological resilience has a role in reducing the risk of depression. Individuals with high levels of psychological resilience are protected from stress with lower levels of anxiety and depressive symptoms. Resilience plays a role that alleviates the negative effects of stressors, actively increases and supports positive psychological well-being.

Resilience, which is an individual’s ability to show resilience, develops a positive perspective and maintains emotional balance in the face of life’s stresses, difficulties, and changes. The pursuit of both physical and mental health, that requires a potentially significant source of strength, purpose, coping mechanisms, and healing and recovery, have linked health outcomes with spirituality, which has been recognized in the literature as a resilience-oriented approach when dealing with stress and potential risks, including its applicability to adults and even children. Spirituality leads to better psychological resilience, given its significant role in protecting and promoting mental health and resisting adverse influences.Religion has a positive impact on an individual’s mental health, primarily by giving believers the chance to perceive some negative events from a constructive perspective. Those who embrace various facets, including behavior, cognition, and emotion in a religious and spiritual lifestyle develop a profound emotional connection with the Creator, which provides them with emotional strength and endurance. An individual’s connection to God can serve as a trigger for personal growth involving devotion, healing, and selfimprovement. Religion offers a unique mechanism for spiritual recovery that can alleviate individuals’ personal difficulties. This improvement manifests in the individual’s psychological spiritual well-being and has a positive impact on their mental and physical health. Resilience comprises elements such as spirituality and religious perspectives, in addition to personal convictions. Religiosity, which appears as visible beliefs and practices can serve as a source of inner strength during challenging and traumatic circumstances, contribute to the prevention of depression and reduce feelings of death and anxiety.

Researchers have defined spirituality as a transcendent side, as body-mind spirit integrity is an important life factor that is studied in both theology and health fields. Spirituality is considered as a significant standalone predictor of resilience in individuals grappling with depression and hopelessness. Elements linked to spirituality such as happiness, social support, self-help and gender are among these factors. Spirituality has positive results on mental health and resilience issues. Psychological resilience involves adapting to challenging life circumstances. The relationship between psychological resilience and mental health is multifaceted. The relationship between these two concepts involves an interaction where one can affect the other. Since psychological resilience helps individuals cope with stressful situations more flexibly, people who show greater psychological resilience in the face of challenging life events or stressors tend to better protect their mental health. Spirituality, which includes deep inner processes such as finding the meaning of life, recognizing their values, dedicating themselves to a purpose and strengthening their social connections, provides resilience by improving the capacity of individuals to make sense of the difficulties they experience. Spirituality has a role that can both increase psychological resilience and positively affect mental health. Coherence pertains homeostatic balance in healthy individual, representing harmonious interactions of the body׳s subsystems, with external relationships, and implies global order, structure, harmony, and alignment within and amongst systems. Coherent electromagnetic fields form stable patterns of biological rhythms in coupled states, resulting in synchronized oscillations. Biocommunicative processes in biology rely on coherent oscillations to induce biochemical reaction. (519-548)

**Psi** is defined as a means by which information can be obtained from a distance without the use of the ordinary senses, and encompasses a broad range of experiences including putative telepathy (mind–mind connections), clairvoyance (perceiving distant objects orevents), and precognition (perceiving future events).Psi also includes mind–matter interactions (psychokinesis),which is the ability to influence external matter without the use of any known physical mechanism. Neuroanatomical regions postulated to have a role in mediating psi include the reticular formation, right parieto-occipital areas, and occipital region, primarily on the right. Although brain laterality data suggest a role for the right and left hemisphere in psi, the right hemisphere may be more associated with this phenomenon than the left. Frontal brain systems act as a filter to inhibit psi and that the inhibitory mechanisms relate to self-awareness, which can be defined as self-focused attention or knowledge. Peripersonal space (PPS) is a construct referring to the portion of space immediately surrounding our bodies, where most of the interactions between the subject and the environment, including other individuals, take place. Decades of animal and human neuroscience research have revealed that the brain holds a separate representation of this region of space: this distinct spatial representation has evolved to ensure proper relevance to stimuli that are close to the body and prompt an appropriate behavioral response. Over time, the human brain has developed the ability to categorize perceptual inputs into a unified, self-centered frame of reference for organizing spatial information. Extensive clinical and experimental research has shown that the brain encodes spatial information in three distinct manners: personal space, which corresponds to the surfaces within and outside the body; extrapersonal space, referring to the area farther away from the body; and peripersonal space (PPS), which encompasses the region where all physical interactions between the individual and the surroundings ocur. These three distinct definitions of space are represented separately in the primate brain and patients with focal brain lesions who experience spatial neglect exhibit clinically distinguishable impairments in each of these spatial domains.

PPS is defined as the space where the human body interacts with the surrounding environment. One of the core neural mechanisms underlying PPS representation is the remapping of visual information into body-centered coordinates such as head-centered, limb-centered, or trunk-centered coordinates. The neural representation of the body and its immediate surroundings is so deeply interconnected that the construct of PPS bears substantial similarities and overlaps with the concept of body schema in psychophysiological terms suggesting that the conscious experience of having a body, known as body ownership may depend on multisensory integration processes involved in PPS representation.The encoding of objects in the PPS is key for complex movement planning, including reaching, grasping, and manipulation, which requires a strict interaction between the neural systems involved in PPS representation and the premotor system. This interaction is dynamic and bidirectional, as evidenced by the fact that movements like grasping or walking can induce adaptations in PPS extension around the body parts involved in those movements. This adaptive response is use-dependent and transient: the spatial representation has been shown to expand only if the tool is actively used (rather than passively held), and “shrinks back” to the original size after the end of tool use. During their use, tools are incorporated as a part of the body schema, and the space surrounding the tools is processed as surrounding the subject.

Behavioral studies have provided evidence that visual attention is enhanced for stimuli located close to the hands, suggesting that encoding of objects in the PPS may facilitate grasping and drive visuospatial attention towards objects that are within immediate reach. This idea has been extended to propose that PPS representation has evolved to enhance the perceptual salience of objects within proximity to the body, which can then be identified as immediately relevant for interaction, suggesting a central role for PPS representation in visuospatial attention.In addition to its role in grasping and motor planning, the representation of stimuli in the PPS requires a heightened attentional response to prepare for and coordinate defensive responses against unwanted intruders. When objects rapidly enter the PPS, such as looming objects, they trigger an immediate attentional response due to their potential as a threat to the subject, immediately activating adaptive mechanisms required for avoidance and defensive behavior. This concept of PPS as a “safety margin” around the body highlights the interaction between sensorimotor integration and the neural systems involved in emotional and behavioral responses to stressors and threats. Emotional states, such as anxiety, or trait psychological factors, personality traits, can influence the boundaries of PPS representation. The close relationship between PPS representation and emotional processing explains why PPS is relevant for social interactions. Studies have shown that the presence of other individuals can modify the extension of PPS, and their perceived moral character, hostility, or cooperativeness can influence the size of PPS . These findings suggest a strong influence of the “social brain” on the multisensory integration underlying PPS representation.The concept of PPS serves as a crucial bridge linking various domains of brain function, including spatial perception, self-perception, body schema, motor planning, visuospatial attention, emotional and social cognition. Alterations in PPS representations have been observed in numerous clinical conditions, from brain lesion-related neuropsychological syndromes to psychiatric disorders like anxiety, schizophrenia, and autism .

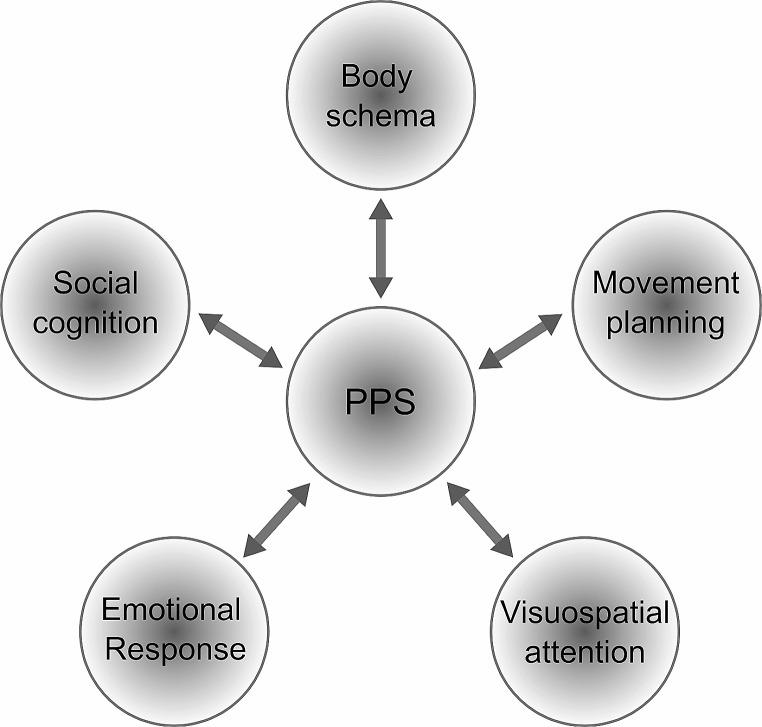


Fig. 84.PPS representation as a bridge between psychobiological domains. The diagram emphasizes the relevance of PPS representation as a link between different brain functions

Regions involved in the detection of behaviourally relevant environmental stimuli have been identified as part of the so-called *salience network*. Core nodes of this network include the anterior cingulate cortex, the anterior insula, the superior temporal gyrus, and the amygdala though the involvement of supramarginal gyrus and premotor cortices have been also reported. This network has been suggested to mediate the shifting of attention towards internal or external salient stimuli (“stimulus-driven attention”) and to broadly overlap with the *ventral attention network*. Together with the cingulo-opercular network, the ventral attention and salience networks, are encapsulated in the midcingulo-insular salience network. Dynamic interaction between brain networks has been pointed out as crucial for higher-order cognitive processing. Functional networks in the brain may not exist as static entities, but rather as superordinate approximations of dynamic, context-dependent states.The dorsal and ventral attention networks have been shown to co-activate during reorienting of visuospatial attention and the ventral frontal cortical regions, including the PMV, may mediate the interaction between the systems. The functional connectivity pattern of the inferior frontal junction, which shows strong functional coupling with the frontoparietal network, shifts towards ventral regions during stimulus-driven attentional conditions. The perception of the space around one’s body is a fundamental mechanism that allows us to efficiently navigate and interact with the environment through an integration between our sensory inputs and motor responses. Disturbances in PPS representation have been increasingly documented in various neuropsychiatric disorders, such as stroke, hemispatial neglect, schizophrenia, and autism spectrum disorder (ASD), and in traumatic injuries affecting the spinal cord and the peripheral nervous system. In this wide range of conditions, PPS disturbances have been associated with deficits in movement planning, body ownership, spatial awareness, and social interactions, thus underlying the paramount importance of PPS in maintaining motor control, spatial awareness, and adaptive social behaviors.

In the mental states associated with psi, mental immersion leads to the loss of awareness of oneself and immediate surroundings. Altered states such as meditation and hypnosis, decrease self-awareness, a state difficult to attain, which can be reduced from frontal lobe damage. The frontal lobe acts as a filter to inhibit psi. The concept of self-awareness being involved in the mechanisms mediating the brain’s inhibition of psi may explain the mind–matter interaction effects. In particular the left medial middle frontal region involving one or moreof Brodmann areas 9, 10, and 32, may act as a biological filter to inhibit mind matter interactions, termed brain–matter interactions. Parapsychology can be defined as the scientific investigation of psi phenomena, which includes what has been called *extrasensory perception,* or ESP, and psychokinesis, or PK. The former refers to being affected, consciously or unconsciously, by spatially or temporally distant events, without the mediation of the senses, technology, inference, or mere chance. PK refers to the direct effect of willed or unwitting mental processes on physical processes, whether at the atomic level or at the perceptual level.The common division of ESP into telepathy (knowledge of information in the mind of a sentient being), clairvoyance (knowledge of information about a non-sentient object like a computer screen or an unseen card) and precognition and retrocognition (knowledge of future or past events that the person could not ­reasonably know or infer) is used in common parlance.

Psi is the scientific study of experiences that cannot be explained by the existing science. Psi is a general term including both extrasensory perception (ESP) and psychokinesis (PK). ESP is a general term used for information acquisition other than by conventional sensory processes of sight, sound, taste, touch and hearing; PK is an ability that influences the environment seemingly by intention or other mental activity alone without motoric intervention. Seven factors seemingly have a possible link with Psi performance are: aging, relaxation, emotional response, experimenter effects, magnetic field, personality and belief. In the light of the discoveries of modern physics, everything is connected and there is a synchronism between the mental state of an individual and an event in the world of matter. Despite several subsequent removals of parts of their brain, the rats continued to preserve memories. The same human ability to draw instantly on any memory, between billions of pieces of information confirm the non-localization of memories, and the non-classifiable nature of time.

Japanese monkeys (Macaca fuscata) on Koshima Island wash sweet potatoes. This fact is quite well known, and is often discussed as an aspect of“ culture" in nonhuman animals. Sweet-potato washing (SPW) is a behavior in which monkeys take a sweet potato to the edge of the water and wash the sand offthe potato with waterA group of monkeys, who lived on a Japanese island, had acquired the ability to wash sweet potatoes before eating them. It was discovered earlier, that another group of monkeys living in another island had acquired the same technique. The two groups were obviously not in physical contact but the information. In ancient tradition, the individual is more taken as a psychological being. The modern medicine has divided the body, separated the psychology and soma. A trend toward personalized and holistic medicine especially in traditional and complementary medicine integration considering the human being as a bio-psychological-social and spiritual being, has been emphasized. A group of monkeys, who lived on a Japanese island, had acquired the ability to wash sweet potatoes before eating them. It was discovered earlier, that another group of monkeys living in another island had acquired the same technique. The two groups were obviously not in physical contact but the information, according to the theory of morphic fields, had travelled non-locally and synchronously reaching other members of the same species. The process of life is intimately connected with the process of the observer who looks at reality. A bio-system’s own psyche is able to interact as an «observer» with the observed in a fully conscious way.

Quantum theory which has replaced mechanistic theory, forces to revise the current medical approach to human being. So medicine has to reconceptualize the approach to the patient, the diseases and the therapeutic modalities, reconsidering the patient as a whole being, and the importance of communication with the patient visualising all his environment such as relatives, parents, families, friends, neighbors etc. and the mind’s power. If the body does not exist, the brain would not exist. Without the existence of the brain, the mind would not exist. Finally, there are no two different identities. The brain-a part of the bod, but is also the control center at the same time. It is not just a somatic anatomical body but also an electromagnetic field which surrounds a colorful aura. Getting through informational channels as meridians, it will be possible to detect and treat the disturbances at an energy level which can be called energy medicine. The disturbances can be found at an early level and be cured without pharmacological or invasive interventions; this means without complications, drugs nor side effects, a cure which is not realized by the current methods. Instead of cure, the patients are presently labelled with a disease and become life time dependent on drugs, and need new medicines to suppress the side effects. Just a confidential and trustful communication can be the main method to help and heal the patient, instead of taking the patient as a virtual identity with a set of symptoms and signs supported by biochemical or microbiological analyses together with radiologic images or electrical measurments.

A physical model is characterized by how it represents physical states, observables, measurements, and dynamics of the system under consideration. A quantum system is a number of physical degrees of freedom in a physical object or set of objects. The physical state (standard view) of a system is a mathematical object which represents the current knowledge about the system, and from which all measurable physical quantities relating to the system can be calculated. A special class of quantum states are called the pure states. The state of a spin-half particle lives in a two-dimensional Hilbert space, such systems is called a quantum bit or qubit. Pure states are called state vectors. Conventional science and quantum physics represent two different perceptions and explanations of reality. The conventional biomolecular framework assumes that the biocommunication is operated in living systems primarily from chemically mediated interactions. The emergence of quantum physics led to new models for subatomic interactions.

Quantum field theory introduces the concept of a field as a space-filling primary entity that creates, connects, and destroys particles. [Researchers](https://www.sciencedirect.com/topics/medicine-and-dentistry/researcher) are finding evidence that quantum theory provides the most accurate model of physical reality and that the underlying principles may be useful in a healing context. Besides significant implications for understanding the relationship between consciousness and human health, quantum theory may be implemented in a healing context by ıts underlying principles. Quantum Physics–inspired models are proposed to describe a wide variety of the psychological and physiological processes that could not be explained or have been difficult to explain through traditional assumptions. Clinician’s awareness of the application of quantum theory to human health, has the potential to enhance relationships, trust, and open communication to facilitate an integrative approach to patient through bi-directional flow of energy.

Energy medicine (EM) is medicine based on physics instead of biochemistry. Energy medicine works with subtle forms of energy known as chi or prana that exist in and around the human body. EM treats with the understanding that all illness results from disturbances in this energy known as the human biofield. Physics is the study of energy. The human body is made of energy. It has structure (bones), plumbing (digestive tract), and electricity (nervous systems), all infused with energy. Energy is a property of all matter, therefore cells, molecules, and atoms are all made of energy. Science has begun to measure the subtle but important energy field around the human body and research is showing that when the natural flow of energy is obstructed, disordered, and depleted, the body becomes diseased. Pharmaceuticals affect chemical signals in the body but EM affects electromagnetic signals in the body. EM heals using an integrated system that supervises the interaction of all the body’s systems and is not only faster, but more efficient. A continuous, uninterrupted flow of energy through the biofield plays the main role in health and healing. In 1989 the term *energy medicine* was coined by the International Society for the Study of Subtle Energy and Energy Medicine which studies the science of medical and therapeutic applications of subtle energies.Veritable energy medicine which uses mechanical vibration (sound) and electromagnetic radiation (light) in order to affect health and healing and involves the use of specific, measurable wavelenghts and frequencies to treat patients. Examples of veritable forms of EM are the use of lasers and magnetic pulses which have been found to be therapeutic. Commonly used forms of veritable EM such as electrocardiogram (ECG), electroencephalogram (EEG), computerized tomography (CT or CAT) Scan, Magnetic Resonance Imaging (MRI) and ultrasound equipment are being used in traditional medical applications.

Biological systems such as cells communicate as chemical or electrical signaling not only with each other attributed to electromagnetic fields (EMF s) but interact with their environment. Putative energy medicine is based on the idea that human beings are able to influence subtle forms of energy with their hands, intentions or meditation. [Energetic](https://www.sciencedirect.com/topics/medicine-and-dentistry/energy-transfer) phenomena in humans may be understood through quantum physics principles. Concepts from quantum physics can be applied to describe information transfer and dynamic relationships within the human system. The bioenergetic aspects of human physiology include molecular energy fields in and between [cells](https://www.sciencedirect.com/topics/medicine-and-dentistry/cells) and their interactions with other energy fields. Information exchange is vital to all living systems whether the communication is inter- or intra-cellular, [organ](https://www.sciencedirect.com/topics/medicine-and-dentistry/organ) to organ, brain to body, or individual to individual.  Experimental evidence support that some aspects of human cognitive abilities impacting communication such as [intuitive judgment](https://www.sciencedirect.com/topics/medicine-and-dentistry/heuristics) and [awareness](https://www.sciencedirect.com/topics/medicine-and-dentistry/awareness) of context, are better explained using quantum rather than classical models. Quantum physics transcends conventional notions of signaling and information transfer.

Photons are the carrier of time and the Universe is a network automaton: a graph of evolving relationships where the vertices represent atoms and the edges represent the hot-potato protocol of a continuously (in perpetuity) bouncing back and forth of a photon. The concept of subtime carries many of the hallmarks of entanglement. Photon entanglements represent reversible, bounded intervals of reversible subtime. Indeed, the only realistic intervals that we can measure are those that span the space/time path of the photon and are terminated by the atoms. Intervals in subtime are therefore finite and bounded by the symmetric emitter and absorber atoms. What goes on inside entangled systems is both timeless and unobservable. Only rare interactions (observations) with the outside define the order of events that we see. Entangled systems are dark. Many more events can occur in subtime (ts) than can be observed from a Tc vantage point: well below any Nyquist threshold. Quantum measurements will thus yield random results.

Neuroanatomical regions postulated to have a role in mediating psi include the reticular formation, right parieto-occipital areas, and occipital region, primarily on the right. Although brain laterality data suggest a role for the right and left hemisphere in psi, the right hemisphere may be more associated with this phenomenon than the left. Frontal brain systems act as a filter to inhibit psi and that the inhibitory mechanisms relate to self-awareness, which can be defined as self-focused attention or knowledge. In the mental states associated with psi, including mental immersion leading to loss of awareness of oneself and immediate surroundings and altered states such as meditation and hypnosis, self-awareness is found decreased. In this sense, psi may be facilitated by reduced self-awareness.From a neuroanatomical perspective, there is a well-established literature relating self-awareness to frontal lobe function, and relating frontal lobe damage to reduced self-awareness. Thus it may be postulated that the frontal lobes act as a filter to inhibit psi and that the neuro-psychological mechanisms mediating this inhibition include self-awareness. The concept of self-awareness being involved in the mechanisms mediating the brain’s inhibition of psi may explain the mind–matter interaction effects. The frontal lobes, and in particular the left medial middle frontal region involving one or more of Brodmann areas 9, 10, and 32, may act as a biological filter to inhibit mind–matter interactions, perhaps better termed brain–matter interactions.

In the quantum realm, the ultimate laws of nature are not subject to the principle of causality - they are nothing more than a mandala of shapes that synchronize matter and interconnect it in all its parts – in the psychological and cognitive realm. In the light of the discoveries of modern physics, everything really seem connected. Despite several subsequent removals of parts of their brain, the rats continued to preserve memories in a trial. The same human ability to draw instantly on any memory, between billions and billions of pieces of information confirm the non-localization of memories, and the non-classifiable nature of time. (549-556).

**Informatıon**

A new concept enters deeper and deeper in the sciences today: information. The structuring of the matter is related to the information as a consequence of structuration process. From the informational point of view, the characteristic information carried by genes, is a matter-related information contained/ integrated into the cell and this form of expression shows the relation between information and its matter support. Within the matter-related informational systems, the information is contained into the intimate structure of the material system, formed by multi-particles, unified with specific forces and characterized by both entropy and information. When the degree of atomic order is high, the entropy is low and such structures contain a high quantity of incorporated information.Information per se belongs to the world of structures and does not have mass, but its representation (carrier) in the form of a physical structure possesses mass. In the physical world, genes, and neurons, for example, process information to convert it into knowledge. They communicate information, which is represented as biological and neurological structures, using chemical or electrical signals. In the digital world, a ‘bit’ of information does not exhibit mass, but a physical material that represents the bit indeed has mass. The same bit can have multiple representations in the form of physical material (e.g., a symbol on a paper or a state of a flip-flop circuit, or an electrical voltage or current pulse). Information is carried by the physical structures in the same way thermometers “carry” temperature. it is important to know how to derive properties of information from properties of information representations and information carriers, and the general theory of information (GTI) provides efficient means for performing this. The general theory of information (GTI) states that “knowledge is related to information as the matter is related to energy”. At the same time, the material structures in the physical world carry the information that represents the state and the dynamics of the structure under consideration.

In the physical world, material structures are governed by the transformation laws of matter and energy, that has the potential to create or change material structures. All physical and chemical structures, which are created or changed by the transformation of matter and energy, obey the laws governing their transformations. All physical structures contain potential information that characterizes their structure, the functions of their constituent parts interacting with each other and with their surroundings, and their behaviors when internal and external factors cause fluctuations in their interactions. There is a definite relationship between the characteristics of physical objects allowing the possibility of the conversion of mass into the energy of physical objects described by these characteristics. The famous formula E = mc2 connects the energy and mass of physical objects. The states of physical structures and the regularities of their evolution are described by the laws of physics, which are mental structures created by humans (mainly by physicists and mathematicians). Living organisms have developed physical structures that exploit matter and energy transformations to acquire a unique identity and the ability to sense and process information that is carried by material structures and convert it into knowledge in the form of mental structures. While all living organisms have varying degrees of the ability to perceive, process, and convert information into knowledge, humans have developed the highest level of representing and managing mental structures using ideal structures in the form of named sets or fundamental triads. The fundamental triad provides the schema and operations to create knowledge in the form of entities, their relationships, and their evolution consisting of event-driven behaviors. Events are caused by fluctuations in the interactions among the components of the structures and their interaction with their environment. Functions, structure, and fluctuations play important roles in the system’s microscopic and macroscopic behaviors. Mental models created by processing information are observer-dependent, as they depend on the previous knowledge of the observer in addition to many other idiosyncratic factors.

In the mental world created by living organisms, information received from the environment using the five senses enables mental representation and is converted into mental structures formed of fundamental triad. There are two forms of mental structures—those that are derived from external observations and those that are created by the human mind representing the ideal structures. Mathematics is used to represent the ideal structures and operations with them, as well as to model the systems from the material world, their states, and evolution.The mental reality (mental world) consists of various mental structures, which participate in the transformational processes involving information and knowledge. These transformational processes are defined by the physical information-processing structures, which consist of genes and neurons. The formula that is similar to Einstein’s mass–energy equivalence also exists in the information realm of mentality. Information is not physical by itself but has a physical representation and this physical representation complies with physical laws. According to contemporary psychology, the brain is only the carrier of thoughts and feelings, the nature of which is essentially not physical. In particular, thinking is defined as “a mental process that involves the manipulation of information. If one atom abandons its particular site, the entropy of the system increases and implicitly the disorder (or freedom) degree, by emission of information. These are specifically defined as processes of embodiment/disembodiment of the information. An integrated atom in a specific site incorporates (embodies) information, by valence bonds with the neighbourhood atoms in the structural lattice. When these inter-related bindings are broken, the system turns into a new state, with higher entropy, because incorporated information is lost by this info-disembodiment process, which generates the genetic information, incorporated (embodied) in the cells, as matter-related information, if certain specific conditions are fulfilled.

The epigenetic processes, allowing to transfer to the offspring the info-acquired traits during the life, follow the same type of informational mechanisms. A special category of sensorial capacity of the mind should be attributed to the detection of the near-death (NDEs) and religious and mystic (RMEs) experiences, besides other extra-sensorial phenomena like premonition, generated by the mind power. Near-death experiences (NDEs) are episodes of disconnected consciousness that typically occur in situations that involve an actual or potential physical threat or are perceived as such, and the experiences are characterized by a rich content with prototypical mystical features. It is possible to detect such experiences during the clinically proved cessation of the brain and heart activities, same in both normal and blind people. This relation shows that each individual is a distinct entity, not only as the matter structure is concerned, but also from informational point of view, according to the personal features inherited from the parents and the habits acquired during the life.

To manage the body by means of information, these systems should be connected to sensors – the sensitive elements of the body transmitting information from the internal and external sources, and to transducers and motor-type execution elements, responsible to convert the info-signals emitted by the brain into the chemical or physical action. The informational system is managed by the brain, as an informational distribution support. The received information acquired by this system and incorporated into the cell by epigenetic overlapping processes, can be transmitted to the offspring, through the genetic matter related support, an expression of the maximum level of info-integration in matter, able for reproduction. The analysis of the distinct functions of the brain from the informational perspective is possible on the basis of the distinction between the virtual information, operated by mental processes, andthe matter-related information, particularly genetic information, incorporated into matter, as an info-material support. The process of the embodiment/disembodiment of information, defined as a basic process describing the interaction of information with matter, allows to understand the mechanisms of the info-integration into (or info-emission from) the matter-related components, from the perspective of the Informational Model of Consciousness. This analysis revealed the main and distinct categories of brain informational activities, grouped as follows: info-perception and memory, info-operability and decisional activity, info-emotional activity, automatic maintainability of the body, info-genetic transmission and info-genetic reception. Information is the central concept to understand consciousness and its properties. Consciousness is a consequence of the operational activity of the informational system of the human body. Consciousness can be connected to the environment not only by the common senses, but also by a special connection pole to the bipolar properties of the universe, allowing to explain the associated phenomena of the near-death experiences and other special phenomena.

As the electrical connectivity by means of the nervous system is already proved, allowing the application of the analysis and developing tools of the information science, a particular attention is paid to the non-electrical mechanisms implied in the internal communication. For this, it is shown that the key mechanisms consists in embodiment/disembodiment processes of information during the inter and intra communication of the cells. This process can be modeled by means of, and in correlation with specific concepts of the science and technology of information, referred to network communication structures, represented by epigenetic mechanisms, allowing the acquired trait transmission to the offspring generation. From the perspective of the informational model of consciousness, the human organism appears as a dynamic reactive informational system, actuating in correlation with matter for adaptation, by embodiment/disembodiment processes of information.

that exhibited during the near-death experiences

(NDEs) (Fracasso and Friedman, 2011; van Lommel,

2006), showing a non-locality state of mind

(Gaiseanu, 2017a), the remote communications

by mind (Radin, 2006), cannot be explained by

the classical laws of physics, so it was necessary to

approach consciousness taking into account the

quantum mechanics properties of particles and

particle systems (Radin, 2006; Hameroff, 1998;

Hameroff and Penrose, 2014; Shan, 2018). Even so,

other categories of psychological properties of mind

like the remote diagnostics (Myss, 1996), remote

exploration of various geographic regions (Meijer,

     

phenomena associated with NDEs like the regression

to the childhood, extracorporeal view, peace and light

brightness, the crossing of a “tube”, or psychokinetic

(anti-gravitational) phenomena (Rae et al., 1999;

Radin, 2006; Radin, 2018; Bösch et al., 2006), cannot

be approached only by the entanglement property

The approach of consciousness from an

informational point of view had been opening new

perspectives for understanding of consciousness

(Dehaene et al, 2014), starting with the analysis

of the brain activity as an inter-relation between

various processors (like in the computer devices)

     

1988), and continuing with a model of the perception

based on a Fuzzy approach (Perlovski, 2001), with

      

a hierarchic entropy/informational type analysis

       

statistical functions (Tononi, 2004; 2008; Tononi et

al., 2016) or the mathematical theory of Kolmogorov



relevant researches.

only recently consciousness was





as the Informational Model of Consciousness (IMC),



and able to approach, explain and interpret in terms

of information the parapsychological properties of

mind (Gaiseanu, 2016a,b; 2017a,b,c), on the basis of

the latest results of quantum mechanics experiments

showing that the disembodiment of information

from particles themselves (Gaiseanu, 2016a) is

a real possibility (Aharonov et al., 2013) and of

astrology (Gaiseanu, 2016a), revealing the matter/

antimatter (dark matter) structure of universe

(Hajdukovic, 2013). The approach of the separation

of information from physical particles (Aharonov et

al., 2013) in terms of information and matter-related



dark matter as a new player in the info-panorama of

the universe and consciousness (Gaiseanu, 2016a)

       

(Gaiseanu, 2016a; 2017b,c). If today is generally

admitted that information is a fundamental property

of nature (Gaiseanu, 2016a; Pepperell, 2018;

Meijer, 2013a; Davies, 2010), this is a consequence

      



in physics (Tegmark, 2014; Gates, 2010; Verlinde,

2010) showing that it is possible to operate with

information as a physical parameter (Verlinde and

thereby refs) to discover the laws of matter and of

the living structures (Gaiseanu, 2016a).

Continuing this line, and observing the dual,

informational (YES/NO-type) structure/behavior of

universe (matter/antimatter, gravity/antigravity,

entropy/anti-entropy, action/reaction, etc.), it was

      

human being is a bipolar info/matter structure

(Gaiseanu, 2016a; 2018d), and consciousness, so

information, could be disembodied from the matter

support (informed matter), as a distinct entity during

NDEs (Gaiseanu, 2017a; 2018a).

The components of the informational system of

the human body act in an integrated form, information

playing a role in every of its forms, from “free” to

genetically embodied information. By convenience,

       

this is not yet related to the body matter. As the

genetic info represents the maximum embodied

degree of information, the info-integration degree

should vary from free (corresponding to zero) to

closely embodied information under a genetic form.

Therefore, the intermediary levels of info-integration

will be simply referred as matter-related information.

The axis represented in the left side of Fig. 1 indicates

the increase of the integration degree of information

from the info-connection pole to matter connection.

This axis allows a qualitative evaluation of the degree

of info-integration in the components of informational

subsystems, represented also in the left side

The chemical communications could take place

by paracrine (within a relatively short distance),

synaptic (at the junction between two nervous cells)

and endocrine (large distance) signals. These kind

of signals consist in molecules of proteins or other

type of molecules, known under the generic name of

ligands, which are produced by the sending cell and

are released into the extracellular space. According

to such a mechanism, only certain types of cells are

sensitive to certain type of ligands, that which possess

the suitable receptor bind on their surface (Albert et

al., 2008; Sogin et al., 2003; Barritt, 1992; Gawad et

al., 2015). This mechanism seems to be similar with

the operational informational unit IF (condition)

=> THEN (consequence), in the computer software,

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These mechanisms take place basically by

a YES/NO type action. In other words, the signal

coming from the upstream molecules turns ON

       

then in a downstream and turns OFF (inactivates)

(Asashima, 2010), similarly with a YES/NO process in

the computing systems. The cellular communication

plays a fundamental role in the biological life for the

maintenance of the functions of the organism under

normal conditions, as a whole. This communication

allows actually the adaptation of the cells to the

conditions of the extracellular environment,

controlling the development, growth, immunity, the

regulation of the metabolism, altering or maintaining

the differentiated state, determining whether the cell

should divide, or if it will live or die. The errors of

communications may result in cancer growth and

diabetes (Gawad et al., 2015).

The intracellular communication pathways

can be actually regarded as an interconnected

network where the signals are processed along

multiple parallel routes of interaction, like in

the computer-based networks, known as neural

networks (Sogin et al., 2003). This is an example of

collaboration between the information science and

life and neuro-science to understand better how

nerve cells distribute and process information in the

brain, which can be correlated with the properties

of the intracellular signaling. Following this line of

correlation, the connections between the computer

units in the neural networks could be considered

analogous with the synapses in the nervous system,

so the cell signaling network can be viewed as a

neural network, able for adaptation processes

The human body appears in such way as a bipolar info-matter (or informed matter – IM) structure, connected both to information (field) and to (ordinary) matter. Within such a structure, one of the important cognitive center, besides Ik (memory), Iw (decision), Il (emotion), Ia (self status), Ic (genetic transmission) and Icd (genetic inherited reception) is the so-called Ib center, which is the connecting pole with information, particularly with the anti-entropic field of anti-matter assimilated, according to some of the last discoveries in astrophysics, with dark matter. Ib could be associated with the protection feeling and with trust, specific for the religious experiences, and also with the meditation process, serving for stress relaxation, as a hypnotic-based palliative therapy and as a learning and psychic reprogramming processes of mind.

In terms of information science (certainty/ uncertainty <=> information/entropy) , the transition from a multi-state level of possibilities explored by the mind (i.e. from a high incertitude, expressed by a high entropy), to a certainty level represented by only one (desired) objective (so information), by means of a “collapsing” (reducing) process like in the quantum mechanics, is an anti-entropic mechanism, yielding equilibrium, peace, serenity and health . This is a powerful process, because the dissipated energy between many possibilities (uncertainty) is reduced to only one, according to the main objective, helping the achievement. The components of the informational system of the human body act in an integrated form, information playing a role in every of its forms, from “free” to genetically embodied information.

As the genetic info represents the maximum embodied degree of information, the info-integration degree should vary from free (corresponding to zero) to closely embodied information under a genetic form. The repetition converts certain information or a chain of information in an automatic prototypes. The chemical communications take place by paracrine (within a relatively short distance), synaptic (at the junction between two nervous cells) and endocrine (large distance) signals. These kind of signals consist in molecules of proteins or other type of molecules, known under the generic name of ligands, which are produced by the sending cell and are released into the extracellular space. Only certain types of cells are sensitive to certain type of ligands, which possess the suitable receptor bind on their surface. When a receptor of the target cell binds a signaling ligands, a series of chain reactions take place into the interior of the cells.In the particular case of the transmission by a nervous cell, when a cell fires due to an input stimulus, an electric signal moves rapidly along the axon to the synapse (the junction gap between two cells), triggering the release of vesicles with ligands (in this particular case named neurotransmitters) to the neighboring target cell receptors. After this step of transmission, the sending cell “resets” rapidly in a standby state, prepared to receive another new signal. The electric signal is carried by a mechanism of the type “all or nothing”, implying an operation by ion channels and electrical potential along the cellular membrane.

The nervous cell fires (“switches” to an ON state) or not (OFF state) similarly with a YES/NO informational mechanism. The paracrine signaling is important during the growth of tissues allowing that the neighborhood cells to understand what type of identity to proliferate. Whereas paracrine communication refers to external groups of cells, the autocrine communication consists in a reception at the surface or in own bulk of some ligands produces by the cell itself. This mechanism is very important to reinforce itself correct identity, having a key role in cancer. The endocrine signaling refers to the intercellular communication by hormones. The electrical signals are characteristic for the nervous cell, but the communication between the rest of the cells and nervous cell junction is performed by molecular physico-chemical processes, so by a matter-related support. A physico-chemical mechanism sustains the nervous cell inter-connection. Information in such type of mechanism is transferred by embodiment/disembodiment of information. These terms points out the nature support of information, distinguishing it from the electrical transmission. When a matter supported signal – initiator (for instance a ligand molecule), transfers information to another component of a system (for instance a cell surface receptor) by binding to it (physico-chemical mechanism), this corresponds with a disembodiment process of information from the initiator, and an embodiment process of information by the receiver. The information is transferred either inside or outside of the cell. This type of mechanism is typical for the cell communication.

Information can be disembodied from particles (body) themselves, as a distinct entity. These mechanisms take place basically by a YES/NO type action. The signal coming from the upstream molecules turns ON (activates) a specific signal in the target, passing then in a downstream and turns OFF (inactivates) similarly with a YES/NO process in the computing systems. The cellular communication plays a fundamental role in the biological life for the maintenance of the functions of the organism under normal conditions, as a whole. This communication allows actually the adaptation of the cells to the conditions of the extracellular environment, controlling the development, growth, immunity, the regulation of the metabolism. The errors of communications may result in cancer growth and diabetes. The intracellular communication pathways can be regarded as an interconnected network where the signals are processed along multiple parallel routes of interaction, like in the computer-based networks, known as neural networks. The new characteristics (traits) acquired during the life of a person can be transmitted to the descendants. Such a transmission, studied by a relatively new science, i.e. epigenetics is performed in such a manner that the genetic structure is not modified at the cellular level, the acquired information is distinctively reproduced by the subsequent generations of cells. An epigenetic trait is a stably heritable phenotype (observable properties of an organism produced by the interaction with the environment), resulting from changes of the chromosome without alterations in DNA sequence.

The genotype is the genetic constitution of an individual organism, expressed by the particular type and arrangement of genes. The chromosome, which is a structure in all living cells, consisting of a single molecule of DNA (double helix structure) bonded to various proteins (histone molecules anchoring it), carries the genes determining the heredity. The eukaryotic cells are the organelles, enclosed by a plasma membrane, contrarily to the prokaryotic unicellular organisms, which do not have a membrane. The basic epigenetic mechanisms can be discussed taking into account three main categories of signals, which culm (A) The “epigenator” is a signal emanated from environment and which is able to activate/initiate/ trigger the subsequent intracellular pathway category of signals, defined in (B) as “initiator”. As a signal (information), the epigenator could be a protein-protein interaction, or a modification based event (matter-related information) which could trigger a second internal signal, that of the “initiator”. One of the most important characteristics of the epigenator is that this info-signal should persist in the cell for an enough long time, in order to be able to unleash the epigenetic phenotype processes, although it is subsequent events step. This characteristic could be clearly associated with the repetition process as an imprescriptible condition at the macrolevel of the organism, to acquire an automatic, stable trait.

At the cellular level, the epigenator disembodied the external information, transferring it to the initiator, which embodied the received information. B) The epigenetic “initiator” is the informational local intracellular response of the chromatin to the “epigenator” info-signal. The chromatin is the material composing the chromosomes, and consists of a complex of DNA (30-40%), RNA (ribonucleic acid, 1-10%) and proteins (50-60%, termed histones), assuring the dense package of DNA structure to prevent its damages, and playing an essential role for the DNA reinforcement during the cell division and the regulation of the gene expression and DNA replication. The proportion of these components varies not only for different species and for various tissues of the same organism, but even in the same cell, depending on the various stages of the cell cycle. The initiator defines the location on a chromosome where the epigenetic chromatin state should be established and could be a DNA-binding protein, a noncoding RNA, or any other entity (matter-related info) that can define the coordinates of the chromatin structure to be assembled. The initiator info-signal disembodying the carried information, may be self-reinforced or self-renewed through positive (self-amplified) feedback mechanisms. It is sufficient that the initiator to induce in the cell a phenotype process and remain inside of the cell together with the “maintainer”. (C) The epigenetic “maintainer” signal (embodied information), sustains the induced modifications in the first and subsequent generations. This step consists in various pathway forms, like DNA methylation (DNA methylation is the substitution of a methyl (−CH3 ) group to the carbon atom in position 5 of a DNA segment), histone modifications and variants (most epigenetic interventions occur on the histones that coat/anchor DNA), nucleosome positioning, chromosome coating with (long) noncoding RNAs, and others. A nucleosome is a structural unit of a eukaryotic chromosome, consisting in a finite length of DNA, coiled (anchored) around a core of histones.

The maintainers dispose of the common property that they can operate at any chromosomal location to which they are recruited by the initiator. They carry the acquired embodied information during the cell cycle or in the differentiated cell types. On such a way, the cells may keep the memory of the info intervention and embodied from their ancestors to their descendants, allowing that cells with the same DNA structure to have distinct properties. These properties are stable over time and are transmitted by cell division. When the expression level of a gene becomes sufficiently high, the epigenetic feedback regulation is achieved, which further activates the expression and vice versa. The activity of the epigenetic feedback regulation and of gene expression dynamics depends on the cellular activity, expressed for instance by the growth rate. In terms of information, this is actually an informational YES/NO-type bistable mechanism. In such a dynamic process, gene expression in a cell refers to the synthesis of the corresponding protein, which may affect the expression of other genes, thus giving rise to a regulatory network.

Gene is a specific functional unit sequence on the chromosome of DNA or RNA, able of inheritance transmission and expressi an epigenetic trait is a stably heritable phenotype resulting from changes in a chromosome, without alterations in the DNA sequence, the main role of DNA being to encode the genetic instructions required to synthesize proteins, the basic “bricks” that ensures the proper functioning of the cell. Analyzing the mechanisms involved in the initiation, spreading, maintenance and heritability of epigenetic operational (“marks”) signals, there were observed in vivo a few common characteristics of them:

(a) the multi-stability:

(b) their spatial patterns (3D structuration);

(c) their heritability.

Epigenetic marks are chemical covalent modifications involved in the basic epigenetic mechanisms, either DNA (DNA methylation) or histones modifications, as the maintainer signals. The bistability (so the informational basic mechanism) is a general property of the epigenetic processes, the epigenetic marks acting as switches YES/NO between different functional states. In the simplest case, different patterns of epigenetic marks allow to switch between two states that have a well-defined functional characterization (bistability). Such functional states are then inherited by the daughter cells, called heritability. During the growing process, the stem cells differentiating process, depending on the sort of tissue, implies epigenetic mechanisms. During their development, including the initiation, stabilization and propagation stage of the patterns of gene expression, the stem cells are able of differentiating to the desired fate, through dramatic epigenetic modifications, becoming finally stabilized and heritable. Epigenetic marks actually act as “switches” between different functional states, like in computers, where the switching operation is performed by some specialized integrated components (commutation transistors). The reduction of the possible (multi)- states of uncertainty, to one certain state, by means of such physico-chemical mechanisms, is actually a process of information embodiment, and the quantity of information integrated into the system can be expressed by a difference of entropy between the two different situations. Schizophrenia is a serious disorder of cognition, which is manifested by inability of normal behavior in social situations and in performing everyday cognitive tasks. New proofs of the implication of the epigenetic mechanisms have been reported both in the long-term (consolidated) memory and in the dysfunction of the epigenetic processes in diseases like anxiety, autism, depression, epilepsy, substance abuse.

The labile short-term memory state can be converted to a stable longterm memory state, through a process referred to as a memory consolidation. The new growing field of “neuroepigenetics” is basically supported by the study of epigenetics at brain level, showing that some memories simultaneously reconsolidate in multiple brain regions, i.e. amygdala, hippocampus, and anterior cingulate cortex after retrieval. As the intra and extra signaling of the cells are actually parts of a communication process, this could be analyzed by the tools of the information and technology of information. In a communication process, similarly as in the microelectronic systems, the communication participants are: the source (transmitter), a receiver, a transmission channel and a coder/decoder system. In the biological communication systems, the messages are transmitted and received such that the cellular machinery realizes the processing of these messages according to its needs. Inside of the cell, the transmitter is assimilated with nucleus, where the information is stored/generated in DNA and transmitted by RNA. In a communication electronic system, the receiver consists of the blocks demodulator/decoder where the information is received, while in an eukaryotic cell, this role is played by organelle.The cellular signaling and feed-back response are some of the main pathway allowing the communication of different parts of the body, either by electric or non-electric signals. These signals carry the information to cells and inside of the cell by means of information embodiment/disembodiment mechanisms. The complex functions in the high level organisms like the human body can be modeled and understood by using the tools and analogy with the processes approached by the science and technology. The communication between the cell implies a transmission agent and a specific receiver at the surface of the target cell.

If a certain emotional state is insistently induced, the specific ligand and complementary receptor on the surface would establish a stable pair of promoters of the same emotion (or state), because the body cells themselves could “ask” the same type of emotions, if they are lived repetitively. This is a feed-back cellular mechanism, like a drug dependence. Such an embodiment process of information, start from the receipt information as a result of the interaction with environment, in a stable, transmissible form to the next generation.The human body is actually an active informational system, able to transform the free receipted information, resulted from the interaction with the environment for adaptation, in an automatic info-prototype and finally in an epigenetic transmissible information, expressible through the acquired traits, by means of information embodiment/disembodiment mechanisms. In terms of matter-related information, this is referred to cellular mechanisms, which intimately encode the operational information and can transmit it in a stable form.

Connection and adaptation to the environment conditions is a dynamic informational process, which involves the integration of information into the operative and functional informational system of the body through epigenetic mechanisms of embodiment/ disembodiment of information. This process allows the long-term acquisition of new attributes, expressed generations. The human organism appears as a global informational processor for adaptation and survival, embodying the convenient information (info-input) and disembodying information (infooutput) as attitude, info-genetic or out-body consciousness entity. This behavior demonstrates the high degree of intervention of information in the evolution of the body, determining its current and subsequent functional development, along one or more generations, under the form of matter-related information. Consciousness is enriched by the life experience and is maintained as a separated entity by a natural disembodiment process of information during the death of the organism.

The human body is actually a bipolar structure, composed by information and matter, where the information has a primary role in the modelling of the body material components, the mind-body complex acting as a reactive/ adaptive info-material system as a function of the external dynamic conditions. The brain is like a total flight simulator, a self-modeling airplane that, rather than beingflown by a pilot, generates a complex internal image of itself within its own internalflight simulator. The image is transparent and cannot be recognized as an image by the system. Operating under the condition of a naive-realistic self-misunderstanding, the system interprets the control element in this image as a nonphysical object: The “pilot” is born into a virtual reality with no opportunity to discover this fact. The pilot is the Ego. There is neither an ‘I’ nor a ‘he’ nor a ‘you’ nor even an ‘it’; neither the thing, nor the nothing; neither a law nor a system; neither the terms nor the relations. But there are only the cognitive events caught for a moment in a stream. The non-dualist alternative, is to treat the distinctions between inside and outside, subject and object, mind and world as distinctions drawn within experience as a continuous dynamic interplay of ‘mental’ and ‘physical’ factors.

The epigenetic processes, allowing to transfer the info-acquired traits during the life, follow the same type of informational mechanisms. Information in the mind is virtual. The informational operator of the mind, the thought, activates the “stand-by” information which is still not active, like in a computer memory by bringing on the virtual screen, either from external, internal or memory domain. Emotions are also informational signals, generated as a reaction to the virtual information detected in the conscious mind by two main emotional categories: impulsive/spontaneous emo-reactions and emotional states (emo-states). Distinguishing between the virtual and matter-related information drawn *within* experience as a continuous dynamic interplay of ‘mental’ and ‘physical’ factors constitute our embodied being-in-the-world.

Information is conserved in the photon link between two atoms comprising an entangled system. Information transfer is negative with respect to the transmitter and positive with respect to the receiver. This symmetry is broken when an observation is prepared which triggers the flow of energy and information–establishing a casual and thermodynamic direction. Causality is symmetric. There is no privileged role or direction for the observer and observee relationship. For every action there is an equal and opposite reaction. Just as effects must have causes for them to exist, causes must also have effects for them to exist. Measurements of information will be different (and opposite in sign) for each observer from their vantage point. Interactions are reversible. Links comprise a photon bouncing back and forth between a pair of atoms.

Consciousness, the informational architecture of consciousness consists of seven groups of specific activities:

1.centre of acquisition and storing information (memory),

2.centre of decision and command (decision),

3.centre of emotional states (emotions),

4.centre of body maintenance (power and health),

5.centre of genetic elaboration/transmission (reproduction)

6.infogenetic generator, inherited from the parents (predispositions, talents and skills).

7.centre dedicated to the connectivity with some extra-power properties of the mind

The sensitive elements of the body, the sensors, that transmit information from the internal and external sources, to transducers and motor-type execution elements, are responsible to convert the info-signals emitted by the brain into the chemical or physical action. The informational system is managed by the brain, as an informational distribution support. The received information, incorporated into the cell by epigenetic overlapping processes, is transmitted through the genetic matter-related support, as an expression of maximum level of info-integration in matter of the distinct functions of the brain from the informational perspective on the basis of distinction between the virtual information, operated by mental processes, and the matter-related information, particularly genetic information, incorporated into the matter, as an info-material support, to the brain informational activities such as info-perception and memory, info-operability and decisional activity, info-emotional activity, automatic maintainability of the body, info-genetic transmission and info-genetic reception.

The atoms are not the last link of matter. Eliminating layer by layer, the matter, at the end remains actually an informational system. The human body is a bipolar structure, composed of information and matter, where the information has a primary role in modelling the body material components to form a mind-body complex acting as a reactive/ adaptive info-material system against external dynamic conditions.To manage the body by means of information, these systems should be connected to sensors – the sensitive elements of the body transmitting information from the internal and external sources, and to transducers and motor-type execution elements, responsible to convert the info-signals emitted by the brain into the chemical or physical action. The informational system is managed by the brain, as an informational distribution support. The received information acquired by this system and incorporated into the cell by epigenetic overlapping processes, can be transmitted to the offspring, through the genetic matter-related support, an expression of the maximum level of info-integration in matter, able for reproduction. The analysis of the distinct functions of the brain from the informational perspective is possible on the basis of the distinction between the virtual information, operated by mental processes, and the matter-related information, particularly genetic information, incorporated into matter, as an info-material support. The process of the embodiment/disembodiment of information, defined as a basic process describing the interaction of information with matter, allows to understand the mechanisms of the info-integration into (or info-emission from) the matter-related components, from the perspective of the Informational Model of Consciousness. This analysis revealed the main and distinct categories of brain informational activities, grouped as follows: info-perception and memory, info-operability and decisional activity, info-emotional activity, automatic maintainability of the body, info-genetic transmission and info-genetic reception. (557-561)

***Bıophysıcal Lıght***

Life on Earth depends primarily on photosynthesis. In photosynthetic organisms, such as cyanobacteria, eukaryotic algae, and land plants, light energy from the sun is converted to chemical energy by two large membrane protein complexes, photosystem II and photosystem I (PSI),[https://www.jbc.org/article/S0021-9258(20)39006-2/fulltext](https://www.jbc.org/article/S0021-9258(20)39006-2/fulltext#FN3)  embedded in the thylakoid membranes. Using light energy, PSI catalyzes light-driven charge separation and transfers electrons from plastocyanin to ferredoxin (Fd) with nearly 100% quantum efficiency. The reducing equivalents generated downstream of PSI are finally utilized to produce organic matter, and PSI is recognized as an indispensable protein complex on Earth..Photosystem I (PSI) is a large pigment–protein complex mediating light-driven charge separation and generating a highly negative redox potential, which is eventually utilized to produce organic matter.Understanding the mechanism of chemical reactions in solution or enzymes at a molecular level is a challenging task in computational chemistry because of the large number of degrees of freedom. The free energy change or potential of mean force rather than potential energy change during a reaction process in a complex environment is a central quantity. Molecular dynamics (MD) simulations from tens of picoseconds to hundreds of nanoseconds are necessary to achieve converged statistical sampling for free energy calculations. The change in electronic structures in bond forming or breaking processes requires in addition a quantum mechanical description such as density functional theory (DFT) on the system, which limits the MD application to a small number of atoms for a short time. The combined quantum mechanical and molecular mechanical (QM/MM) method, provides a multiscale computational tool to allow a reliable quantum mechanical calculation on the active site with a realistic modeling of the complex environment. Although the QM/MM model has been further developed with great success to study many biological and chemical reactions, it requires electronic structure calculations at each step during MD samplings. To overcome the limitation originated from the physical approximations or fitness functions, machine learning techniques such as neural network (NN) are being increasingly used as a sophisticated force field for molecular simulations. The first goal on machine-learning-based QM/MM simulations is to describe potential energy landscapes with an ab initio accuracy and a force field computational cost. In the generalized neural network representation, the total potential energy is expanded as a sum of atomic energies, and each atomic contribution is dependent on its local chemical environment that can be described with a set of symmetry functions as input vectors of NN.

Density functional theory (DFT) is a quantum-mechanical (QM) method used in chemistry and physics to calculate the electronic structure of atoms, molecules and solids. The study of the electronic and optical properties of organic systems is crucial to a large variety of fields, including photovoltaics, photochemistry and photosynthesis. Extensions to conventional DFT that allows the calculation of excited-state properties have been developed. Modern DFT simulation codes for solid-state calculations can calculate a vast range of structural, chemical, optical, spectroscopic, elastic, vibrational and thermodynamic properties, also including computational results in experimental studies on materials and surfaces. A large number of programs for calculations on periodic systems using either plane-wave or atom-centred basis sets are available and under active development. Closely connected in research practice to the procedure of structural optimization is the calculation of vibrational frequencies. They are used not only for simulating infrared (IR) or Raman spectra but also for characterizing the nature of stationary points as minima or transition states. The information obtained from such a calculation is used to compute statistical thermodynamic corrections to the electronic energy to make direct comparisons with experimentally determined free energies. Mössbauer spectroscopy is an invaluable spectroscopic technique in bioinorganic chemistry, since it is able to probe selectively the charge and spin distribution for example around iron centers. DFT appears reliable for geometries, vibrational frequencies, and total energies, having over wavefunction-based methods the advantage of quick convergence to the basis set limit and successful for the prediction of molecular properties as well.

Antenna proteins, crucial components of photosynthetic process, transmit the excitation energy over a distance up to tens of angstroms to another molecule by the process of resonance energy transfer (RET) or electronic energy transfer (EET). Biophysical light interacts with the human self-organization of information by means of biomolecular, metabolic, or neural communication. The transport of electronic excitation energy (EET) between ions, atoms, molecules or chromophores is an important process that occurs in a wide range of physical systems. The tantalising prospect of effective experimental control over such transfer is, in principle, amenable to a variety of different kinds of approach. Several of the most promising, which are analysed and compared in this paper, involve the influence of externally applied static electric or electromagnetic fields, or the exploitation of local media effects. A quantum electrodynamical framework is used as a common basis to describe the corresponding mechanisms, illustrated by specially adapted Feynman diagrams. It becomes evident that energy transfer between polar species engages an additional pairwise interaction beyond the EET coupling. Such an effect may also play an important role in interatomic Coulombic decay (ICD), a process that has recently attracted fresh interest. The control of ICD, in which the photoionisation of two nearby atoms via energy transfer, is determined to have analogous characteristics to conventional forms of EET.

The absorption of ultraviolet–visible (UV-Visible) light by condensed phase dielectric materials generally results in the promotion of ions, atoms, molecules or chromophores to short-lived electronic excited states. In optically pure media that lack effective channels for complete energy dissipation, a degree of fluorescence will commonly ensue—yet the site of fluorescent emission will often differ from the site of initial excitation. In the short time interval between the photon absorption and emission events, single- or multi-step electronic energy transfer (EET) of the excitation may occur between proximal particles. Over short, sub-wavelength ranges, each such transfer step takes the form of a radiationless pairwise interaction, typically between electronically distinct particles. One of the particles (the excited particle, the initial absorber) acts as the energy donor, the other as an acceptor. The same mechanism also operates in atom physics, where photoexcitation of a donor atom leads to indirect ionisation of a nearby acceptor. The associated pairwise energy transfer can still be described in the same way as transfer between molecules or chromophores, based on a description cast in terms of quantised field interactions. There is an important difference: in suitably complex, heterogeneous condensed phase media, multi-step resonance energy transfer may arise, usually exhibiting a spectroscopic gradient. This signifies that a small amount of energy is lost through vibrational relaxation after each transfer step, which means that back transfer from each acceptor to its energy donor becomes exceptionally inefficient. Similar effects can be observed in quantum dot systems.

An essential feature of EET (also known as resonance energy transfer, RET) is the process that occurs spontaneously, by engaging quanta of the vacuum field. Quantum-coherent intermolecular energy transfer plays a key role in light harvesting in photosynthesis and photovoltaics. A direct, real-space demonstration of quantum coherence in donor–acceptor systems has been lacking because of the fragile quantum coherence in lossy molecular systems.The transport of charge via electrons and the transport of excitation energy via excitons are two processes of fundamental importance in diverse areas of research. Characterization of electron transfer (ET) and excitation energy transfer (EET) rates are essential for a full understanding of biological systems (such as respiration and photosynthesis) and opto-electronic devices (which interconvert electric and light energy). From the birth of life, solar energy has been the driving force of life. Via the mechanism of photosynthesis, living organisms capture sunlight with the highly sophisticated pigments in their antenna systems and transfer sunlight energy to the reaction center (RC) in the form of electron-hole pairs (excitons), where it is stored as biochemical energy[1](https://www.nature.com/articles/s41467-022-29621-w#ref-CR1). The transfer of solar energy from antenna to RC, which is also known as excitation energy transfer (EET), in the form of excitons is considered to be highly efficient with close to unit efficiency. Experiments showed that the long-lasting coherence in the efficient natural light-harvesting complexes (LHCs) is preserved by the surrounding protein environments (scaffold), and this coherence may be responsible for this high efficiency[https://www.nature.com/articles/s41467-022-29621-w](https://www.nature.com/articles/s41467-022-29621-w#ref-CR5).

Resonance energy transfer, also known as Forster- or fluorescence- resonance energy transfer, or electronic energy transfer, is a photonic process whose relevance in many major areas of science is reflected both by a wide prevalence of the effect and through numerous technical applications. The process, operating through an optical near-field mechanism, effects a transport of electronic excitation between physically distinct atomic or molecular components, based on transition dipole-dipole coupling.

Resonance energy transfer (RET) , theb transport of electronic energy from one atom or molecule to another, has significant importance to a number of diverse areas of science. An individual RET process, which arises after excitation of the donor, involves light emission at one molecule and light absorption at the other. This means that RET can be described in terms of photon creation at the excited donor and annihilation events at the unexcited acceptor because of the quantum properties and the retardation effects of the mediating light, which leads to the concept of a photon. A full quantum description is necessary to describe the RET process ovger all distances, because the electronic energy is not transferred instantaneously. The transfer of energy between molecules occurs via the exchange of a virtual photon, which has increasingly real (transverse) characteristics as the intermolecular separation grows. The term virtual is indicative of the fact that the photon is reabsorbed before its properties, such as wavelenght. The dipole of each molecule is crrectly decribed asa transition dipole moment, connecting two non-degenerate energy states of the molecule. RET coupling between molecules near a surface plasmon that acts as a bridging material for the energy transfer, since plasmons are the collective excitations of conduction electrons by light, which reşide in a confined metallic structure. By coupling plasmonic materials to RET chromophores, a substantial amount of energy transfer can occur over significantly larger separations than the RET between conventional materials – up to distances approaching the optical wavelenght. Resonance energy transfer occurs in the ultraviolet or visible range of the electromagnetic spectrum, which is comparable to the energy required for electronic transitions in molecules etc. At the lower end, in the infrared range, transfer of vibrational energy can arise between excited (donor) and unexcited (acceptor) oscillating bonds on adjacent molecules.RET is a process by means of which the

energy of an excited atom or molecule

(usually called the donor,butknown

historically as the sensitizer)istrans-

ferred nonradiatively to an acceptor

molecule (‘‘activator’’), through inter-

molecular dipole–dipole coupling. The

origins of its discovery can be traced

back to 1922, when the phenomenon

of RET (‘‘sensitized ﬂuorescence’’) was

ﬁrst experimentally observed by Franck

(1922); Cario (1922); Cario and Franck

(1922) in the gas phase. This spectro-

scopic experiment involved illuminating

a mixture of mercury and thallium va-

pors at a wavelength absorbed solely by

the mercury; the resulting ﬂuorescence

spectra was proven to include frequen-

cies that could only be emitted from

thallium. Such energy transfer in vapors

was at ﬁrst assumed to be uniquely asso-

ciated with interatomic collisions, but

a discovery that transfer could occur

at larger separations than the collision

radii showed that this was not neces-

sarily the case. Soon, RET was also

being observed in solutions (Gavi

Resonance energy transfer is a mech-

anism that is now known to operate

across a diverse and extensive range of

physical systems, encompassing not only

gases and dye solutions but also protein

complexes, doped crystals, polymers, and

so on. Nonetheless, at a fundamental

level, it is possible to identify numer-

ous common features in the underlying

photophysics

After photoexcitation, energy absorbed by a molecule can be transferred efficiently over a distance of up to several tens of angstroms to another molecule by the process of resonance energy transfer (RET) (also commonly known as electronic energy transfer, EET). Examples of where RET is observed include natural and artificial antennae for the capture and energy conversion of light, amplification of fluorescence-based sensors, optimization of organic light-emitting diodes, and the measurement of structure in biological systems. In Förster resonance energy transfer (FRET), energy non-radiatively transfers from a blue-shifted emitter to a red-shifted absorber by dipole–dipole coupling. Resoanance energy transfer (RET), also known as known as fluorescence energy transfer, (FRET) or electronic energy transfer, EET) is an optical process, in which excess energy of an excited molecule, usually called the donor, is transferred to an acceptor molecule. Fundamentally RET involves two types of elementary particles: electrons and photons. In RET, all the electrons (including dynamically active electrons) are bound to the nuclei of the molecules, and reşide in their valence molecular orbitals. The individual electrons do not migrate between molecules during the transfer process, since the molecular orbitals (the wavwefunctions) do not overlap, but insteadmove between individual electronic states within the molecules. This is fundamentally different to the ultar short range Dextre energy transfer, where electrons migrate between molecules via covalent chemical bonds. In RET, on relaxation of the electron to a lower energy electronic state in the donor, the excess energy is tarnsported to the acceptor in the form o0f the emitted virtual photon. This transfer is facilitated by dipole-dipole couplings between the molecules. Photons play two distinct roles toward the process: one as the mediator of donor-acceptor transfer, and the other as an external energy source that promotes donor valence electrons into an electronic excited state via an absorption process prior to RET.

The organization of any biological system, established in a complex electrodynamic field, is determined by its atomic physicochemical components, and their behavior and orientation. The holographic model of reality, provides a scientific explanation of psychoenergetic phenomena. The human body vibrates between 4 and 10 Hz with amplitudes of 10 mm. The physiologic functions of the lungs, joints and bones are directly influenced by certain combinations of sound vibratory levels through which the human body becomes a musical instrument. A new perspective in the development of electromedicine will reveal new pathways using the latent energies of human body. Every living and nonliving creature on the planet vibrates at its own special frequency. This would include humans too. Different cells within our bodies vibrate at different frequencies to create our own "special song". In the presence of acute or chronic illnesses, these vibrations change. They are also altered by things that we eat and do. The higher the frequency, the lighter and healthier the person. There are a variety of things we can do to increase our vibrations. Obviously, consuming healthy foods and getting adequate exercise is a great contributor towards vibrational health. Simple acts of kindness and increasing our daily gratitude can greatly help as can decluttering one's mind and living space, detoxing from technology, and engaging in a variety of therapies such as healing touch and sound therapies. (562-572)

**Computational Power** .

With the development of deep learning, a convolution neural network (CNN) has gradually become one of the mature algorithms in the field of artificial intelligence. The computational complexity of CNN is higher than traditional algorithms, and the network structure is increasingly complex. Requiring a given neural network to perform (during inferencing) under specific resource-constrained conditions can add to the complexity of the neural architecture search process. For example, designing a neural network to have more than x% accuracy for a given task is a hard problem to solve but it becomes harder if we further constrain the problem with additional parameters such as frames-per-second (FPS) requirements during inferences and power consumption limits. Traditional neural architecture search (NAS) frameworks are typically designed to identify the best architecture within a specified search space. This approach is constrained by its pre-defined search space, which limits its capacity for generating novel neural network architecture (outside the search space). Most NAS frameworks prioritizes final model accuracy leading to very high search-cost (time, energy consumption) and poor edge AI performance (low FPS and high inferencing energy). Methods of neural architecture search (NAS) are extensively used across various applications such as image processing, signal processingobject detection, and natural language processing. It involves identifying the best neural network for a given task through repeated trials, traditionally judged solely based on final model accuracy. Natural visual scenes contain strong positive stimulus correlations in both space and time[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR3). According to the prominent efficient coding hypothesis, the retina’s function is to encode stimulus information without wasting resources on signalling this inherent redundancy of natural scenes. To reduce the redundancy, the retina should decorrelate its output, the spiking activity of retinal ganglion cells, at least as much as the intrinsic noise in the system permits while retaining stimulus information. The popularity of the efficient coding hypothesis is based on its success in explaining characteristics of the early visual system, including centre-surround receptive fields[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR4) and the emergence and spatial organization of retinal cell types

The decorrelation prediction of efficient coding has so far only been tested with stimuli that at most share some statistical similarities with natural scenes such as static images, sometimes including object movement. The natural retinal input is dynamically structured by eye and head movements that rapidly shift the retinal image[5](https://www.nature.com/articles/s41586-024-08212-3#ref-CR5). Such gaze shifts can induce robust response transients at fixation onset in neurons at the early stages of the visual systemshaping the encoding of natural scenes. Correlated retinal activity has been indicated to play a role in increasing spatial resolution[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR43) and error correction[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR47). Because retinal circuit nonlinearities have been associated with computations underlying visual feature detection the response correlations in nonlinear cell types aid in signalling the detection of a relevant visual feature in natural scenes. The mammalian direction-selective (DS) retinal ganglion cells, which are a prime example of feature detectors, have strongly nonlinear receptive fields, and their strong pronounced pairwise response correlations could even exceed stimulus correlations. Correlations may be particularly important for tagging the relevant feature, such as local spatial contrast or the preferred motion signal, and distinguishing it from changes in illumination of the receptive field. Although a single neuron’s firing rate might be confounded by light intensity or other stimulus dimensions to which the neuron is sensitive, the feature of interest may be isolated by combining the activity from groups of neurons[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR51). Further insight into the functional consequences of correlated activity may come from assessing their dependence on stimulus context, such as average light level. Spatial nonlinearities in ganglion cell receptive fields, may decrease at lower light levels[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR52), which should result in decreased stimulus-induced correlations, and noise correlations may become more prevalent.

Efficient coding is considered a natural assumption for sensory systems because of the need to preserve energy associated with neuronal activity. Feature detection may have different requirements than general information transmission, such as robustness or future prediction[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR60), which could lead to deviations from efficient coding. The retinal code may multiplex correlated nonlinear responses containing feature information with decorrelated baseline activity. The retinal output can maintain efficiency in various stimulus contexts while being robust for feature detection. Energy constraints could also be addressed by other mechanisms, such as making responses transient, allowing the visual system to detect important features promptly. The different information channels of the retina may balance energy conservation and robust feature detection on the basis of their respective visual tasks. Neuronal spiking is reproducible with a precision on the order of a millisecond suggesting that the timing of each spike could convey significant information. Schemes where the precise timing of spikes carries information are referred to as temporal coding schemes. Temporal coding allows information to be processed at higher speeds with less energy than does rate coding.

The role of the vertebrate retina in early vision is generally described by the efficient coding hypothesis, which predicts that the retina reduces the redundancy inherent in natural scenes[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR3) by discarding spatiotemporal correlations while preserving stimulus information[https://www.nature.com/articles/s41586-024-08212-3](https://www.nature.com/articles/s41586-024-08212-3#ref-CR4). It has long been accepted that neurons encode information in their spike trains . Many studies have shown that neurons encode information in their average firing rates. Rate coding is the implicitly assumed method of neuronal coding in most studies, even those in which the average firing rate is obtained within a short time window by using an ensemble of neurons Yet, the presence of rate coding does not preclude the possibility of encoding information in other ways.

In the framework of the temporal coding hypothesis, an association consists of more than a mental link between the representations of paired events. The temporal relationship between the events are encoded as part of the association. For a versatile representation of sensory patterns in the nervous system, three basic functions have to be accomplished:

1) elementary features need to be represented by neuronal responses,

2) responses to features constituting a particular object have to be distinguished and bound together in a flexible way, and

3) the specific relations among these features have to be encoded and preserved.

The auditory system functions to collect sound waves from the environment, transform mechanical vibrations from those sound waves into electrical nerve signals, which can be relayed to various areas of the central nervous system, and process sound into meaningful content. The complexity of auditory processing is apparent by the system's ability to localize, analyze, and interpret a sound which extrapolates into useful information that the individual can respond to with simultaneous integration with other sensory stimuli. For a sound to be perceived by the individual, it needs to travel to and be processed by higher-order regions in the cerebral cortex, specifically the primary auditory area. From there, through bottom-up and top-down signaling pathways, the information can be relayed to other areas of the central nervous system, cerebral cortex, and lower brainstem regions to make meaning of the information as well as integrate auditory and other sensory stimuli. The primary auditory area acts as the principal location that receives sounds from peripheral auditory structures and is integral to begin the process of complex sound interpretation as well as the conscious perception of noise. <https://www.ncbi.nlm.nih.gov/books/NBK554521/>The path sound takes from the external environment to the primary auditory area and associated auditory areas, is complicated by many synapses, decussations, and inputs to brainstem nuclei bilaterally and both cerebral hemispheres. As sound waves travel through the air and are collected by the pinna of the ear, they are transmitted down the external auditory canal where they produce vibrations of the tympanic membrane that translates to movement and vibration of three ossicles present in the middle ear, the malleus, incus, and stapes, to further transmit vibrations to the oval window of the inner ear. Vibrations then travel to the cochlea and are sensed by inner and outer hair cells of the organ of Corti, which function to transmit the mechanical energy present in vibrational sound waves into the electrical energy transmitted along the auditory nerve.<https://www.ncbi.nlm.nih.gov/books/NBK554521/>

The auditory nerve then transmits the signal to the cochlear nucleus located between the pons and the medulla in the brainstem. The signal then travels to the superior olivary nucleus in the pons, up through the lateral lemniscus pathway, then to the inferior colliculus of the midbrain, and onto the medial geniculate nucleus of the thalamus, and finally synapsing in the primary auditory cortex. During this travel, information decussates or crosses to the contralateral side of the brainstem. This crossing establishes both ipsilateral as well as contralateral input, with the majority of the fibers taking a contralateral pathway from each ear, which assists in localization and interpretation of sound quality.If the individual hears a sound from a location directly in the midline, the sound reaches both ears simultaneously. If sound production is from one side of a person’s midline, the sound reaches the closer ear before the other ear and will be of a louder intensity due to the individual’s head acting as an “acoustic shadow” to dampen the noise received by the far ear. In addition to ascending input pathways that the peripheral system provides to the primary auditory cortex, there are descending and output pathways that travel from the cerebral cortices down to brainstem nuclei. This top-down signaling pathway from the cerebral cortex allows for modulation of peripheral structures that respond to the attention of the individual as well as the relevance of the auditory stimulation that will dictate the individual’s behavioral response to that sound.

The primary auditory cortex can subdivide into different regions based on structural and functional properties and their cytoarchitecture, the number, organization, and type of neuron, myeloarchitecture, the amount and arrangement of myelinated fibers going to and coming from the cortex, as well as the chemoarchitecture, in different neurotransmitters and proteins expressed in that region of the brain. Each of these regions differs based on their cellular architecture, response to stimuli, as well as their input and output pathways. The associated connections of both the inputs and outputs of the auditory cortical area are structured in a serial and parallel fashion. These various regions of the auditory cortex receive complex signals from multiple sources allowing them to integrate the information into meaningful information that can be relayed to other areas of the cerebral cortex.  Once the information reaches the auditory cortex, more complex integration and interpretation of the stimulus can take place. Each primary auditory cortex has connections within the same cerebral hemisphere as well as between cerebral hemispheres. The destination of the outputs from the primary auditory cortex determines what higher-order and more complex cognitive functions take place with the incoming acoustic information. For example, auditory information traveling to the amygdala has profound impacts on the emotional and behavioral response of an individual, whereas information destined for the premotor cortex are utilized for planning and controlling speech.

The organization of the auditory system, and the corresponding function, depend on the location of the sound-sensitive neurons in that hemisphere, as well as what pathway through which the information is traveling. For example, acoustic stimulation in one ear produces a higher rate of cortical firing in the contralateral primary auditory cortex when compared to the ipsilateral cortex, suggesting a higher number of fibers crossing over in brainstem pathways. Two different pathways are known as major routes for sound information, and each carries its own type of sound information. The ventral stream carries semantic information, which is important for determining the meaning of language and travels from the rostral pole of the temporal lobe to the occipitotemporal cortex. The dorsal stream carries phonological information about sounds from the superior temporal cortex to the inferior frontal cortex, which aids the individual in understanding segments of speech, learning vocabulary, and understanding articulation of words.<https://www.ncbi.nlm.nih.gov/books/NBK554521/>

A common theme present in the organization of the auditory system is that the arrangement of neurons is in a tonotopic manner. This theme originates in the cochlea, with high frequencies located at the base of the cochlea closest to the oval window, and lower frequencies present at the apex of the cochlea. This separation of sound frequencies and the established tonotopic gradient is maintained through each brainstem nuclei present in the primary auditory cortex. Each area is distinct in its function.<https://www.ncbi.nlm.nih.gov/books/NBK554521/>  In the primary auditory area, the location of high frequencies is caudally and medially, while lower frequencies are rostrally and laterally. Development of the central nervous system begins at gestational week three and continues throughout gestation and into postnatal life throughout adolescents and possibly throughout the lifespan. Full development of the cerebral cortex occurs during the postnatal period, where external environmental stimuli shape the developing brain by reinforcing synapses that are required for interaction with the environment, pruning unnecessary connections, and myelinating pathways to provide for faster signal conduction. These normal external stimuli are necessary for proper cortical development and organization, and deprivation of auditory sensory stimuli results in abnormalities in the organization and function of the primary auditory cortex. The majority of input to the primary auditory cortex originates in the contralateral ear.

There is considerable variation in the primary auditory area between individuals. There are also anatomical variations noted between hemispheres. Research has demonstrated that individuals who had the left Heschl gyrus stimulated during surgical procedures reported hearing voices and language; however, with stimulation of the right Heschl gyrus, the patients reported hearing music. Similarly, professional musicians have larger densities and volumes of the right primary auditory cortex when compared to non-musicians. There have also been reported duplications of Heschl gyrus in some individuals, occurring on the left and right in equal frequencies, as well as bilaterally. Interhemsipheric communication has been implicated in various functions of sensory signal processing and perception.Core auditory cortex (AC) neurons encode slow fluctuations of acoustic stimuli with temporally patterned activity. Perceptual judgments depend on neural responses that are unique to individual sensory stimuli. The neural representation can be as simple as the total spike count, or it can take on a more complicated form as the temporal distribution of spikes (temporal code). For example, visual and somatosensory cortex neurons encode behaviorally relevant stimulus parameters with a spike count code that provides sufficient information to guide perceptual acuity. Most natural sounds are composed of time-varying intensity fluctuations, from slow (~1 Hz) to fast (>100 Hz), suggesting that a temporal pattern of activity is required to perform fine perceptual judgments. For example, our ability to distinguish the pitch of a musical instrument must be encoded in the temporal domain, at least in the auditory brainstem.

Modulation of signal amplitude is a fundamental acoustic cue that is present in speech, nonhuman vocalizations, and many other natural sounds. For very fast AM rates, core AC neurons are unable to synchronize to the stimulus, and must encode these stimuli with a spike count code. At intermediate AM rates, described perceptually as “flutter”. AC neurons can provide a sufficient representation through either spike count or temporal codes. In fact, the discrimination of large differences between temporal fluctuation rate in the flutter range may rely on an AC neuron spike count code. In contrast, the peak of the AM spectrum of speech is quite slow at ~4 Hz. AC neuron temporal encoding can easily account for auditory discrimination of slow time-varying fluctuations.The detection, discrimination, or categorization of envelope cues can be based on either of two cardinal strategies: a spike count code or some type of temporal code. For auditory cortex, a spike count code has been proposed to account for AM depth detection threshold, as well as improved sensitivity as the AM depth increases. A cortical spike count code correlates closely with the perceptual acuity of detecting AM stimuli despite the availability of a synchronized discharge pattern that also scales with modulation depth. AC neuron discharge rate can also vary across a narrow range of modulation frequencies. Spike count coding could also support AM discrimination. For example, the discrimination between temporal fluctuation rates within the flutter range (~10–50 Hz) is explained by an AC neuron spike count code.

Although a cortical spike count code is sufficient to explain the detection and discrimination of envelope cues, a temporal code could be required for more demanding perceptual judgments, such as a feature classification. Investigations on the neural encoding principles of communication sounds offer evidence that auditory cortex processing and temporal coding underlie perception for complex time-varying acoustic cues such as speech and animal vocalizations. First, AC lesions lead to severely impaired processing of communication sounds. Second, neurophysiological studies across species demonstrate that natural vocalization sounds are highly represented by AC discharge patterns. Electrocorticography (ECoG) recordings from human auditory cortex utilize high-dimensional algorithms based on temporal signals to decode distinct features of speech. Third, temporal coding of such complex time-varying fluctuations of acoustic cues is correlated with behavioral performance. The spike-timing-based coding strategies that sufficiently represent complex time-varying acoustic stimuli. The ability to make accurate predictions confers clear competitive advantages. Accurately extrapolating the trajectory of a moving object to predict its future state, for example, is very useful for both prey capture and predator evasion. Prediction emerges as a natural consequence of resource optimization, providing dual benefits for adaptive behavior and energy efficiency. The concept of *efficient coding* from information theory describes how to achieve such resource optimization for data storage or transmission. When data are extended in space or time, efficient coding suggests that a *predictive coding* scheme can be used to compress information and save energy.

Predictive coding (PC) is an inluential theoryn in neuroscience, which suggests the existence of a cortical architecture that is constantly generating and updating, predicitive representations of sensory inputs. Many studies have characterized the brain as an efficient coding system in which the brain has evolved to code sensory information in an efficient way by using information-processing strategies optimized to the statistics of the perceptual environment. An influential theoretical and computational framework, closely related to efficient coding, is predictive coding that provides an understanding of the interactions between distinct brain areas. Predictive coding posits that the brain actively predicts upcoming sensory input rather than passively registering it since the brain does not need to maintain multiple versions of the same information at different levels of the processing hierarchy. The activity in lower level areas can be considered an “error signal” that updates the predictions at higher areas and guides learning. The term “predictive brain” depicts one of the most relevant concepts in cognitive neuroscience which emphasizes the importance of “looking into the future”, namely prediction, preparation, anticipation, prospection or expectations in various cognitive domains. Errors of prediction are crucial for driving neural and cognitive processes as well as behavior.

In a very broad sense, predictive processing refers to any type of processing which incorporates or generates not just information about the past or the present, but also future states of the body or the environment. Such directedness towards the future has long been recognized as relevant and beneficial for different aspects of information processing, such as perception, motor and cognitive control, decision making, theory of mind and other cognitive processes in humans as well as, in a more rudimentary form, animals. The ideomotor principle suggesting the existence of shared or common codes between perception and action emphasizing a close interaction between sensory and motor processing within the field of motor control. Motor activity directly influences sensory processing, Executing movements follows sensory processing and decision making while object recognition occurs once low-level visual processing is finished, providing input for higher-level cognitive functions. Throughout the history of cognitive (neuro)science, different terms, e.g., anticipation, expectation, prediction, prospection or preparation, have been used with respect to predictive processing. The term prediction(predictive processing)has been used to describe both a single event expected as an appropriate synonym for expectation and the overall process of postulating “single predictions” for describing the general orientation towards the future which includes a wide range of predictive phenomena.The predictive brain uses its knowledge of regularities and patterns to make increasingly refined predictions about what objects and events are most likely to be responsible for the signals it receives from the environment. Perceptual experience is the top-down “best guess” at the hidden causes of incoming sensory signals. If there is a significant mismatch between prediction and incoming signals, the discrepancy (the residual error, or “prediction error”) moves forward (or “up”) through the hierarchical system helping to refine predictions to recruit actions aimed at making the sensory stream fit proprioceptive predictions, or improving the state of information.

The prediction error minimizing routine is modulated at every level by a set of second-order expectations that track the reliability, or inverse variance, of the predictive system's own estimates given the state of the organism. It uses this estimation of reliability (referred to as “precision weighting”) to flexibly adjust the gain (like turning the volume up) on particular error units that carry all the unexplained sensory information, and increasing their weighting impact of the information on the unfolding process. This allows the system to flexibly modify the degree to which it relies on incoming prediction errors from the sensory periphery or prior beliefs about the state of the world. For example, while listening to your favorite song in the shower, it would be useful to turn down the influence on the sensory signals produced by the flowing water and rely more on our clear memories of the song.

Perception is not explained by incoming signals alone, but crucially includes active top-down predictions about their shape, reliability and what they could mean and involve a kind of “controlled hallucination” impacted by what is predicted to be out there. What is predicted is itself continually tuned by the actual sensory signals, and works (in normal functioning brains) to anchor those predictions to reality. The hard perceptual work is accomplished by the internal “generative model” constructing the predictions, leaving the incoming sensory information the task of criticising the predictions until a better fit is achieved.Scientific thinking about the minds of humans and other animals has been transformed by the idea that the brain is Bayesian. A cornerstone of this idea is that agents set the balance between prior knowledge and incoming evidence based on how reliable or ‘precise’ these different sources of information are — lending the most weight to that which is most reliable. This concept of precision has crept into several branches of cognitive science and is a lynchpin of emerging ideas in computational psychiatry — where unusual beliefs or experiences are explained as abnormalities in how the brain estimates precision.A long-standing hypothesis has suggested that our brain uses specific neuromodulators to achieve a delicate weighting, altering the synaptic gain afforded to top-down predictions and bottom-up evidence based on how precise they are estimated to be. In unstable environments our current beliefs are poor predictors of what will happen in the future. This makes volatility a form of second-order precision estimate, reflecting the reliability of our expectations. When we estimate our environment to be more volatile, noradrenergic neuromodulation increases the gain (signal-to-noise) of incoming signals. This has the effect of upweighting incoming information — enabling rapid learning about potential changes — while also downweighting the impact of old expectations on inferences, since predictions are less reliable in a world that changes often.Precision seems central to how psychologists and neuroscientists think about perception, learning, metacognition and social interaction. Divorcing beliefs about precision from reality gives predictive processing accounts enormous scope to model cognition in health and disease. For example, the hallucinations that characterise illnesses like psychosis can be cast as an ‘optimal inference’ given overly-strong beliefs about the reliability of our expectations. Characteristics of autism, such as a preference for stable and repetitive environments, can be cast as a consequence of overly-strong beliefs about the precision of incoming evidence such that every fluctuation in our sensory systems seems to signal the need to change our models of the environment ( the world seems unstable).Descriptive theories consider what it *is*, whereas normative theories consider what *ought* to be.

Descriptive theories attempt to give an accurate description of reality, whereas normative theories attempt to tell what reality should be like. Specifically, descriptive DT is concerned with characterizing and interpreting regularities of decisions that people are disposed to make. Differently, normative DT seeks to provide an account of choices that people ought to be disposed to make. The distinction between descriptive and normative theories is in their interpretation rather than their mathematical model. Beyond this dichotomy, decision analysts advocate “prescriptive” theories toward solving practical problems in the real world. Prescriptive DT attempt to provide recommendations for decision-makers that conform to desired normative principles and engineer the decisions and bridges the gap between descriptive and normative theories. Problems of supplier selection, such as ranking and sorting tasks, are typical applications of prescriptive DT.

Prospect theory (PT) a typical descriptive DT has been used to characterize the choices that people make as well as to analyze their individual attitudes and subjective beliefs. PT depicts the patterns that are created when people choose among probabilistic outcomes in which the probabilities are uncertain. A common theme in contemporary theories of brain function, ranging from perception to reinforcement learning, is an emphasis on the critical role in inference played by predictions based on prior knowledge. According to these theories, predictions and incoming sensory input each have an associated precision (inverse variance) reflecting their confidence or reliability and is compared against one other, generating a discrepancy signal termed the prediction error, which indicates the difference between the expectation and sensory input. Such prediction error signals update prior beliefs in a manner that is weighted by their associated precision, such that more is learned from precise and reliable prediction errors compared with noisy and unreliable prediction errors.

In the context of reinforcement learning models, a distinction can be made between two types of prediction errors. First, the signed prediction error indicates whether an outcome is better or worse than expected, and plays a crucial role in changing the value allocated to cues, guiding future decisions. A second type of prediction error, the unsigned prediction error, signals the degree of surprise without indicating valence (better/worse than expected). In addition to signed prediction errors, unsigned prediction errors are included in various reinforcement learning models to control how much should be learned from new information. Large unsigned prediction errors signal that the brain’s model of the world is inaccurate, thereby increasing the amount that is learned from new information. This can be achieved in various ways, including a non-Bayesian approach by using a dynamic learning rate parameter or a Bayesian approach by decreasing the precision of prior beliefs across different levels in the hierarchy so that new sensory information has more of an impact on learning. In these hierarchical models both signed and unsigned prediction errors are weighted by their precision.

Predicitve coding is based on the hypothesis that the brain minimizes the prediction errors with respect to a generative model of the world. Both classical and quantum theories provide a tool for model updating the state conditioned to some observations. In a classical Bayesian framework, when an event is observed, the original probability function is changed into a new conditional function. In particular, the joint probability is normalized and this guarantees that the new probability function sums to one. Quantum theory proposes, *mutatis mutandis*, a similar model: the original state vector is transformed into a new state vector through a projection. In particular, the original state is projected onto the subspace of the observed event and then such projection is divided by its length. This transformation of the state vector onto a subspace corresponding to the observed event is called “projective measurement.” The certainty about predictions may lead to uncertainty about evidence (and vice versa), as incompatibility is, “mathematically implemented by the non-commutativity of quantum measurements.

According to the predictive coding (PC) theory, the brain is constantly engaged in predicting its upcoming states and refining these predictions through error signals. Anticipatory or predictive processing is directed towards the future and, at the same time, highly dependent and grounded in the information from the past. This bridging over different temporal points and taking advantage of the past in order to improve behavior in the future is suggested to be the core capacity which makes our cognitive brain so efficient. Specifically, prediction is associated with a wide range of neural phenomena within different brain networks, e.g., changes of neuronal threshold in sensory cortices long-range phase synchronization changes in connectivity across brain regions or existence of preparatory-set cells in the prefrontal or parietal cortex One way to understand predictive processing in perception is to conceptualize anticipation as a bias signal which improves the computational efficiency of a specific area. This description may be useful, as it points to three elements specified in order to understand such a phenomenon: brain regions which formulate expectations and impose such a bias (sources), regions which are influenced by it (sites) and a communication mode mediating this process. Within sites of prediction such as, e.g., relevant sensory cortices, modulations of activity occurring in expectation of a stimulus include a reduction of activation threshold and an increase in signal-to-noise ratio which facilitates subsequent stimulus processing. These effects are reflected in the elicitation of particular event-related anticipatory components, e.g., contingent negative variation, stimulus preceding negativity or the readiness potential and the suppression of specific brain rhythms in the sensory cortices (event-related desynchronization; ERD) as measured using electroencephalography (EEG). Improved speed and accuracy of processing expected stimuli reflects preparatory effects in the relevant sensory cortices coupled with the inhibitory effects in other sensory modalities.

Findings showing that patterns of activity in actual somatosensory stimulation perception and anticipation of such stimulation engage the same network suggest a top-down modulated pre-activation of sensory cortex waiting for the stimulus to occur. A similar pre-activation of areas involved in processing relevant events has been show in other domains, e.g., emotion or pain processing although not consistently. The brain is constantly bombarded with more information from multiple sensory channels than it can process. A critical challenge that it must address is to ensure that only goal-relevant information reaches the level of focused attention and information that does not reach that level cannot and should not be fully excluded from ever reaching it because the information may have behavioral relevance. There is a need for a dynamic control mechanism that permits the flexible allocation of resources to process subjectively important information.

Cognitive control refers to processes that flexibly and adaptively allocate mental resources to permit the dynamic selection of thoughts and actions in response to context-specific goals and intentions.Concepts of cognitive control (CC) and executive function (EF) are defined in terms of their relationships with goal-directed behavior versus habits and controlled versus automatic processing, and related to the functions of the prefrontal cortex (PFC) and related regions and networks. CC is considered in the context of motivation, as “cool” and “hot” forms Many psychiatric disorders and neurological conditions are associated with deficits in cognitive control (CC) and/or dysfunction of the prefrontal cortex (PFC) and its associated circuitry.CC is a term usually associated with the healthy functioning of the PFC and related regions such as the cingulate cortex. The neuroanatomical connectivity of the PFC to most parts of the cortical and subcortical brain makes it well suited for participating in a number of neural networks and carrying out CC operations in different functional domains (e.g., spatial, visual, and verbal).

Many psychiatric and neurological disorders are associated with specific symptoms that may be a product of impaired CC, or with more general cognitive deficits that accompany the specific symptoms. For example, Attention-Deficit Hyperactivity Disorder (ADHD) has major EF/CC impairments in attentional control, working memory, and response inhibition that contribute to DSM-5 symptoms of distractibility and impulsivity. Similarly, some symptoms of major depressive disorder include problems of decision-making and concentration, which appear to entail primary CC impairments. In schizophrenia, negative symptoms have been related to impaired goal-directed behavior and positive symptoms such as delusions and hallucinations to deficits in reality monitoring although there is an additional domain of symptoms in schizophrenia of cognitive impairment that includes major working memory deficits and impedes rehabilitation.Although such psychiatric and neurological disorders are treated as distinct entities, a growing body of work has focused on the observation that these disorders share considerable variance. Whether treated as dimensional or categorical constructs, different disorders are comorbid, either concurrently or sequentially across the lifespan. This common variance occurs at multiple levels of specificity. At one level, particular disorders can be clustered into internalizing (depression and anxiety), externalizing (antisocial behavior and substance use), and thought disorder (schizophrenia, bipolar disorder, obsessive-compulsive disorder) factors. At a higher-order level, these internalizing, externalizing, and thought disorder factors correlate with each other, and these correlations can be modeled with a general psychopathology factor.

Cognitive control is essential to flexible, goal-directed behavior under uncertainty. Because attentional functions are known to allocate mental resources and prioritize the information to be processed by the brain, Cognitive control is required for the flexible allocation of mental resources in the service of goal-directed behavior. The terms “cognitive control”, and “executive control” are frequently used interchangeably in the literature. The ontology of cognitive control has been overwhelmingly such that the constructs described as comprising it (e.g., response selection, response inhibition, and task-set switching, among others) are described as discrete functions, measured by different tasks, with no interactions between them. Cognitive control is most important when there is competition for limited mental resources, a relatively common condition in the brain. Cognitive control serves to reduce uncertainty in decision-making, at various levels, by controlling what information reaches focused awareness. When processing information in the presence of task-irrelevant distracters individuals must actively screen out distracting information or inhibit competing responses in order to accurately implement a response. Efficient performance on these tasks is due to the mental flexibility that cognitive control allows.

As distracting information and/or the number of possible responses increase, uncertainty also increases. One way to examine information uncertainty and consequently the implications for cognitive control is within the framework of information theory. If we consider uncertainty in terms of entropy, or the amount of information that needs to be processed before a response can be made, we can investigate cognitive control in explicitly computational terms. Considering the overlap in neural networks associated with cognitive control and dealing with uncertainty, uncertainty can be viewed as one context that triggers the implementation of cognitive control. Conflict detection and resolution is a special case of cognitive control, functioning to reduce uncertainty and facilitate decision-making.From the inception of the term “cognitive control”, it was described as a limited capacity system employed in the form of cognitive strategies (particularly attentional strategies) consistent with task instructions. Early theories of attention, such as expectancy theory, the early filter model, the attenuation model, the pertinence model, and feature integration are all related to the selection of a subset of sensory information due to a limited capacity for information processing. One early model featured a ‘supervisory attention system’ to account for the willed and automatic control of behavior. Attention can be thought of as subserving cognitive control by modulating information processing in a goal-consistent manner, via the attentional functions. Control processes have been described as being implemented via attention, and since active attention is required, only one process can be controlled at a time without interference from other processes Attention consists of separable,but interconnected brain networks (alerting, orienting, and executive control) that influence computational priority, controlling what information enters conscious awareness. Alerting allows for an increase in vigilance to an impending stimulus and orienting refers to the mechanisms by which information is selected from various sensory inputs. Executive control of attention, refers to those processes involved in detecting and resolving conflict in information processing among competing mental processes. “top-down” control is analogous to endogenous (voluntary and goal-directed) orienting and “bottom-up” attentional control is analogous to exogenous (involuntary and saliency-driven) orienting.

Humans can learn to deal with uncertainties and complete complex tasks, an ability which is called cognition in cognitive science. Cognitive control refers to a set of processes critical for guiding thoughts, feelings and actions in a flexible, goal-directed manner and is critical for the pursuit of long-term goals. Childhood cognitive control relates to other domains of cognitive functioning and predicts later-life success and well-being and is positively associated with a range of outcomes in other domains, notably social skills, academic performance and mental health[https://www.nature.com/articles/s41593-024-01672-w](https://www.nature.com/articles/s41593-024-01672-w#ref-CR9) and is predictive of these outcomes later in life. Cognitive control undergoes protracted development from childhood into early adulthood. This development is underpinned by the maturation of late-developing fronto-parietal and fronto-striatal neural circuitryaffording extended plasticity. Given its critical role in healthy and productive development, coupled with the prolonged plasticity of its underlying neural circuitry, cognitive control has been a primary target for interventions and particularly in childhood[https://www.nature.com/articles/s41593-024-01672-w](https://www.nature.com/articles/s41593-024-01672-w#ref-CR20).Cognitive control refers to the intentional selection of thought , emotions, and behaviors based on current task demands and social context and the concomitant suppression of inappropriate habitual actions. Cognitive control interventions have primarily focused on improving their hypothesized constituent processes, namely working memory, cognitive flexibility and, to a lesser extent, response inhibition[https://www.nature.com/articles/s41593-024-01672-w](https://www.nature.com/articles/s41593-024-01672-w#ref-CR21). For decades, research into the mechanisms underlying how people adjust their information processing to achieve their goals (*cognitive control*) and how they weigh costs and benefits to make a choice (*value-based decision-making*) was conducted largely in parallel.

Functionality refers to the increase in activity of brain regions corresponding to an increase in uncertainty. The activity and connectivity of the frontoparietal network in the cognitive control of uncertainty processing should have a positive monotonic relationship with uncertainty, which is reflected by computational load, determined by both the amount of input information and the algorithms of the mental operations involved. Specificity refers to the modality-independence of the brain regions in the processing of uncertainty when cognitive control is needed. Capacity refers to the maximum amount of information a channel can transmit per unit time. The limited capacity view was central to early views of attention that were influenced by information theory. When the required processing rate exceeds the peak limitation, or when the power of noise in the channel increases, processing efficiency (as measured by both RT and accuracy) decreases.

Salience is a feature of individual objects relating to their appearance frequency within a context or sequence of objects, and so can be quantified by its surprise value. In Bayesian schemes the optimization of precision is seen as an attentional process; however, salience is a bit more complicated. Operationally, salience may be better conceived as a sampling of information that reduces uncertainty. This is fundamentally different from reducing the uncertainty over options—it reduces the uncertainty over states of the world. Salience is quintessentially a measure of the relative entropy or reduction in uncertainty. By virtue of the fact salient can resolve uncertainty about competing explanations. The human body transmits 11 million bits of information per second (bps) to the brain, but our conscious mind can only process a portion of this capacity. For example, reading capacity is estimated as 50 bps, for a typical reading speed of 5 words per second, assuming an average of 5 characters per word and roughly 2 bits per character. Visual attention can select only 30–60 bits of information for processing with each glimpse. Cognitive control is a set of processes that permits adaptive responses consistent with goals and homeostatic demands to constrain the amount of information that reaches focused consciousness and most needed when there is competition for limited resources and a considerable amount of computation required to determine the most appropriate input and response.

Cognitive control is implemented by computational mechanisms of distinct and integrated attentional networks which influence information processing for uncertainty reduction. Attention is defined as the activity of a set of brain networks of alerting, orienting, and executive control that influences the priority of computations of other brain networks for access to consciousness or to output. Alerting is for achieving an alert state (tonic) and the ability to prepare for a sensory signal (phasic). Orienting is for the selection of information from sensory input and turning attention toward a sensory signal (reflexive or voluntary, covert or overt). Executive control detects and resolves conflict and selects one dimension in the presence of competing information or computation. The coordination of the attentional networks, with modality-independent executive control at the top hierarchical level and dynamically implements cognitive control in a context-sensitive fashion. It is the mechanism of so called selective attention to deal with the limited capacity of information processing via selectivity. This cognitive control architecture is consistent with a key principle of the brain, with lower regions for sensory input, modulated by alerting and orienting, and higher regions performing multimodal (or association) functions coordinated by executive control.

Retinal circuits use efficient coding to transform light patterns into the neural code transmitted through the optic nerve. Many basic functional properties of the retina are the result of efficient coding that provides a framework to explain how the evolution and plasticity of cortical circuitry is shaped by natural environmental statistics. Efficient coding is a concept from information theory describing how data can be transmitted or stored with minimal use of energy, time, and resources.

1. Predictive coding is a direct consequence of efficient coding, particularly when applied to sequential or autocorrelated data.
2. A code that is efficient for one statistical distribution is inefficient for other distributions, implying that neural codes should be optimized for the natural environment and ought to adapt to changing environmental statistics to maintain efficiency
3. To efficiently encode sequential data, it is necessary to learn sequence order and, if extended into the temporal domain, timing as well. Prediction emerges naturally as a consequence of efficient coding without requiring a separate representational framework.

Neural structures supporting efficient coding develop generationally through evolution or within a lifetime through unsupervised or self-supervised learning algorithms. “predictive coding,” described as a general principle of cortical function, encompassing development, learning, and efficient neural encoding refers to specific unsupervised learning algorithms, premised on various assumptions about neural structure and function. The efficient code is actually created *via* filtering operations in retinal circuits, which throttle firing rates and decrease redundancy by removing many of the input correlations imparted by natural scene statistics.Information sources that exhibit statistical dependences across space and time can be compressed by efficient encoding schemes. In the visual system, part of this process occurs in the retina and perform spatial and temporal decorrelation relative to the statistical structure of natural visual inputs, Longer-timescale and higher-order correlations present in natural visual inputs survive the initial processing stages. order correlations in natural vision are edges in the spatial domain (representing correlations between spatially adjacent center-surround receptive fields) and brief trajectories in the temporal domain. Neurons with “space-time inseparable,” or direction-selective receptive fields, eliminate higher-order correlations associated with motion trajectories.There are at least two different ways in which efficient coding may shape cortical responses to natural visual flow. Thre first is by forming compressed representations of flow-like inputs by eliminating statistically predictable dependences between neighboring moments in time. Second, though related, external motion relative to the animal creates an unexpected visual input with respect to locally predicted visual flow. In both cases efficient representations would be expected to generate relatively larger responses when unexpected flow patterns violate spatiotemporal predicitions. Even if the system does not take advantage of such a mechanism to conserve energy,it could still benefit from knowing the distribution of flow signals , which necessarily involves some ability the future.

Real world information streams exhibit both ordinal and temporal statsiitcal dependences. A dancer may observe the continous sequence of body movements required to perform a routine, or a driver may learn the discrete order and timing of turns along a route. Natural data streams contain both order and precise timing information. Any accurate model of these streams must describe how often different elements ocur and what order they follow, and when they ocur relative to each other. If the resulting code are efficient, unexpected stimuli should evoke excess activity or prediciton errors , relative to expected stimuli.Depending on the natüre of the encoding, predicition errors could be elicited by unexpected elements introduced to a sequence, expected elements rearranged within the sequence or omitted alltogether, or expected elements presented at unexpected times. The literature contains a variety of terms describing these effects including surprise related enhancement, mismatch negativity and predicition error.

Adaptation describes the time varying behavior of neurons as they adjust firing properties to changes in environmental statistics. A classic example is the change in dynamic of retinal photoreceptors in response to changes in overall light intensity. After adapting to a dark environment, photoreceptor responses saturated at daytime light intensities, are rendered temporally unable to transmit information at these highre intensities. This is precisely the behavior predicted by efficient coding, since it allows neurons to maximize information throughput under changing conditions. Adaptation, in the very early visual system, can be understood as a consequence of efficient coding principles. Natural scenes are non-stationary and dynamic at various timescales. Efficinet coding suggests that neural circuits should learn their dependencies and remove them from the neural code , creating time-invariant representations of objects and other environmental features and allowing for prediction of future states. It is difficult to understand the mechanistic overlap of teh brain between computation and representation. The conscious percept of a particular thought or idea or image emerges from the combined activity of populations of neurons, and their activity defines the neural code representing the idea. The same population partcipates in the output transformations responsible for computation. In a real sense computation and representation are inseparable aspects of neural activity and there are interpretive dangers in focusing exclusively on either.

Information theory provides useful framework to understand how evolutionary pressure toward efficient resource utilization can create predicitve codind schemes with an intrinsic role for time. The complex, spatiotemporal dsitribution of visual infromation means that if the brain uses an efficient coding strategy anywhere, visual areaa are an ideal candidate. Natural visual scenes exhibit autocorrelations that are useful for implying causality and predicitng the future or reconstructing the past. A key insight is that a drive toward efficiency encourages temporal relationships to be represented in the neural code. Efficient coding theory implies that there ought to be selective pressure to learn approximate space time distributions over natural visual inputs and provides an account of how sensory data ought to be encoded and the data is compressed by removal of predictable spatial and temporal information displaying a degree of spatial and temporal invariance and unexpected or unpredictable patterns ought to elicit error signals that are coded by increased firing rates at eithrer individual neuron or population level (e.g. an unexpected stimulus could increase the size of the response population. Computing power, or "compute," is crucial for the development and deployment of artificial intelligence (AI) capabilities. As a result, governments and companies have started to leverage compute as a means to govern AI. Influence theory a systematic study of formal models of the communicative influence of one person or group of people on another person or group is an overarching philosophical discipline that includes aspects of decision theory and game theory as sub-disciplines as well as established models of de facto segregation, cultural change, opinion polarization, and epistemic networks.The vertebrate CNS contains a number of anatomical structures functionning not only as negative but also as positive feedback systems, connected by recurrent three dimensional neural networks that mayo r not require any equivalent of full back propagation through a multilayer network. For instance the hypothalamus continously releases neural and humoral signals processed within a black box of target cells, resulting in either lowering (negative feedback) or enhancing (positive feedback) the discrete neural output.

Transmission at electrical synapses being bidrectional results in spreading changes of cellular membrane potentials to all the partners within an electrically coupled compartment including subthreshold responses such as synaptic potentials as well as spontaneous oscillations, which are generated in every part of the brain. Network oscillations assist to store and retrieve information in synapses and regulate the flow of information in neural circuits. Electrical synapses in the CNS are pivotal for information processing, learning and memory and human conscioussnes displaying analog computaional mechanisms.Electrical synapses facilitating synchronous high frequency gamma oscillations between inhibitory interneurons in hyppocampal pyramidal cells, are involved in the release of pulsatile oxytocin by synchronizing burst firing between magnocellular neurons. In GABAergic interneurons in striatum and cortex, electrical coupling synchronizes the activity of interneuronal networks and neocortical pyramidal cells. When spikes arrive at the presynaptic terminal, they provoke the opening of voltage gated calcium channels (Cav) with subsequent increase of intracellular Ca2 +concentration and quantal vesicular neurotransmitter release into the synaptic cleft, considered as digital events. Even small variations in presynaptic calcium release due to the incoming action potentials not obeying all-or-nothing rules may significantly impact on strenght of synaptic transmission, because of the power law relationship between intra terminal Ca2+ concentration and neurotransmitter release. All of these analog events serve to accumulate voltage in the postsynaptic neuron, which triggers discharge of an action potential when a critical threshold, specific for each neuron, is overcome. Incoming action potentials, both digital and analog entities may vary both in amplitude and width adding to complex signals in neuronal computation. Reduced spike amplitudes from decline of conductance of voltage-gated sodium channels (Nav), due to repetitive firing observed in long term potentiation (LTP) diminish synaptic transmission at hippocampal and cerebellar synapse.

In addition to dendritic spiking events, more analog forms of communication such as the influence of subthreshold potentials on effects of action potentials, transmission of voltage signals through gap junctions or ephaptic coupling between neighboring cells due to slow membrane potential dynamics, close proximity of interacting cells, or large degrees of population synchrony led to the “2-layer” model of neuronal integration.Terminal dendrites represent non-linear and independent thresholding units. The combined output has to pass a second threshold at the cell body. The postsynaptic neuron is a multi-task element within the neuronal network that receives more than thousand messages from other neurons both on its dendrites and cell body. Dendrites are responsible more in decision-making than cell body. In terms of non-linear inhibitory and excitatory inputs in active dendrites, their excitability is under powerful control of local inhibition. Local clustering of synaptic connections in dendritic branches, has a significantly impact on synaptic modifications. This clustered synaptic plasticity has been associated with increased storage capacity and feature binding. The arrangement of synapses in clusters stabilizes long-term memories, because clustered spines are more stable than isolated ones

When presynaptic neurons become correlated, the optimal response becomes non-linear. Non-linear dendrites are essential in neural network computations with their capacities to decode complex spatio-temporal spike patterns. Inputs from presynaptic neurons with correlated activities are integrated non-linearly, while inputs from uncorrelated neuronal activities are integrated linearly. This is achieved in the same dendritic tree by clustered synapses of correlated inputs. There is non-linear summation of synchronous, adjacent inputs on the same dendritic branch, whereas more remote and separated inputs undergo linear combination. Presynaptic neurons with strongly correlated activities are in contact with nearby locations on dendrites whereas independent neurons are connected to distinct dendritic subunits. The optimal response can be expressed as a set of non-linear differential equations that requires storing and continuously updating ∼N2 variables within the dendritic tree, where N is the number of synapses. Highly synchronized spikes superimposed on randomly occurring spikes (quiescent states) can evoke supralinear integration. Synaptic clusters, may be considered as crucial computational and memory storage units in the brain.Bifurcations can be observed on all levels of an individum, from organs to cells and to molecules. There is a critical dependence on the initial conditions which are characterisitc of nonj-linear systems. The salient feature highly reminiscent of fractals is typical of chaotic systems. Specific changes in the brain formed by experience and stored in a quiescent state become functional under conditions that lead to retrieval or in psychiatric disorders.

According to influential theory, simultaneously activated and reinforced synapses in clusters of neurons form the basis for learning and memory. Newly established synaptic weights within an activated neuronal population may result in an engram as the specific connectivity patterns between neurons leading to an expanded storage capacity, because there are significantly greater numbers of combinations of synaptic weights than of neurons in any given cortical network. Distinct populations of neurons encoding engrams for specific memories are distributed across multiple brain regions and conditioned by specific cues associated with incoming signals. Memory reactivation increases engram cell excitability, which enhances retrieval of specific memory content and memory recall can be elicited by its stimulation. Intrinsic excitability of dentate neurons results in self-assembly into a memory engram. The balancing excitation and inhibition events have been termed as homeostatic plasticity.

Neural circuits must maintain stable function in the face of many plastic challenges, including changes in synapse number and strength, during learning and development. Neural circuits are subject to many forces that work to destabilize their activity. For example, synapse-specific correlation-based plasticity mechanisms such as long-term potentiation (LTP) and depression (LTD) contribute to learning and information storage, but theoreticians have long appreciated that they generate a powerful destabilizing force on network function. This is because when synapses undergo LTP they are better able to depolarize the postsynaptic neurons, which increase the probability that they will undergo further LTP—leading to unconstrained synaptic strengthening. Without forces that prevent the excitability of the postsynaptic neuron from changing in response to correlation-based plasticity mechanisms, their specificity breaks down and information can no longer be effectively stored through differences in synaptic strengths. As synapse changes occur during learning and development (e.g., during long-term potentiation), neural circuits become destabilized. Homeostatic plasticity mechanisms (e.g., synaptic scaling) are used to stabilize firing rates. The destabilizing influences are counterbalanced by homeostatic plasticity mechanisms that act to stabilize neuronal and circuit activity. One such mechanism is synaptic scaling, which allows neurons to detect changes in their own firing rates through a set of calcium-dependent sensors that then regulate receptor trafficking to increase or decrease the accumulation of glutamate receptors at synaptic sites. Additional homeostatic mechanisms may allow local changes in synaptic activation to generate local synaptic adaptations, and network-wide changes in activity to generate network-wide adjustments in the balance between excitation and inhibition. To be considered truly homeostatic, a plasticity mechanism should regulate a key parameter (such as average neuronal firing rate) around some set-point value. To accomplish this feat, neurons must sense some aspect of “activity,” generate an error signal when this deviates from a set point, then use this error signal to change excitability in the correct direction to move activity back toward this set point.

Central neurons, that are embedded in complex networks composed of many cell types, including both excitatory and inhibitory neurons, are able to maintain average firing rates around a homeostatic set point. When cortical or hippocampal neurons are induced to fire more than normal, over many hours firing, returns to baseline levels. If neuronal firing is reduced over time, neurons compensate and again firing is restored. Small changes in the balance between excitation and inhibition can have major effects on ongoing activity. “global” mechanisms operate on all of a neuron’s synapses, while “local” mechanisms act on individual or small groups of synapses. Some forms of homeostatic plasticity occur through presynaptic and others through postsynaptic changes in function. Which of these mechanisms are engaged depends on how activity is modulated as well as other factors such as cell type and developmental stage.

The best understood form of homeostatic plasticity at central excitatory synapses is synaptic scaling. Homeostatic synaptic scaling is a form of synaptic plasticity that adjusts the strength of all of a neuron’s excitatory synapses up or down to stabilize firing. Neurons detect changes in their own firing rates through a set of calcium-dependent sensors that regulate receptor trafficking to increase or decrease the accumulation of glutamate receptors at synaptic sites. Additional mechanisms may allow local or network-wide changes in activity to be sensed through parallel pathways, generating a nested set of homeostatic mechanisms that operate over different temporal and spatial scales. Neurons maintain stable firing rates through homeostatic regulation of many aspects of neuronal excitability including balancing inward and outward voltage-dependent conductances that determine firing properties also called “intrinsic excitability”, regulating inhibitory and/or excitatory synaptic strength or synapse number or by adjusting the ease with which other forms of plasticity can be induced so-called “metaplasticity” . These mechanisms contribute to the homeostatic regulation of neuronal firing rates in central circuits.The best understood form of homeostatic plasticity in the central nervous system is synaptic scaling of excitatory synapses, which has been demonstrated both in vitro and in vivo, including spinal neurons and neocortical and hippocampal pyramidal neurons. Pharmacological manipulations of activity induce bidirectional compensatory changes in the unit strength of glutamatergic synapses, over a time scale of many hours.

Miniature excitatory postsynaptic currents (mEPSCs, or “minis”), which represent the postsynaptic response to release of individual vesicles of neurotransmitter can be considered a measure of the unit strength of a synapse. By measuring minis arising from many synapses onto the same neuron, it is observed that modulating network activity increase or decrease the entire amplitude distribution of mEPSCs uniformly, in effect scaling synaptic strength up or down. Such a scaling process has the attractive property of allowing neurons to normalize firing without changing the relative strength of synaptic inputs, thus avoiding disrupting information storage or processing mechanisms that rely on differences in synaptic weights. The rules for synaptic scaling depend on the synapse type: inhibitory synapses onto pyramidal neurons are scaled in the opposite direction from excitatory synapses, suggesting that firing rate is regulated through reciprocal changes in excitation and inhibition.Homeostatic adjustments in excitatory synaptic strength require that neurons sense some aspect of “activity” and translate changes in this activity into compensatory changes in synaptic strength. Neurons can sense changes in their own firing rate and globally scale synaptic weights up or down to compensate, alternatively, local changes in synaptic signaling induce local homeostatic changes in synaptic transmission and synaptic scaling requires widespread changes in network activity through activity-dependent release of a soluble factor by many neurons or glia simultaneously. Synaptic strength is determined by a number of factors in addition to the number of receptors in the postsynaptic membrane. In particular, the number of presynaptic neurotransmitter release sites, and the probability that neurotransmitter vesicles are released following an action potential (“release probability”), are also major determinants of synaptic strength. At the neuromuscular junction there is extensive evidence for homeostatic regulation of presynaptic function. The first molecule suggested to be a homeostatic activity signal for synaptic scaling is brain-derived neurotrophic factor (BDNF) to be released by cortical pyramidal neurons in an activity-dependent manner, and important for cortical development and expression of many forms of plasticity. Exogenous BDNF prevents the scaling up of synaptic strengths normally induced by chronic blockage of activity in cortical cultures. Preventing activation of endogenous BDNF receptors mimic the effects of activity blockade, and scales synaptic strengths up. The pathway through which activity-blockade increases excitatory synaptic strengths is through a reduction in the amount of BDNF released by pyramidal neurons. It concludes that enhanced BDNF release is not essential for homeostatic down-scaling of synaptic currents.

Information transfer at chemical synapses occurs when vesicles fuse with the plasma membrane and release neurotransmitter. This process is stochastic and its occurrence is a crucial factor in the regulation of signal propagation in neuronal networks. The reliability of neurotransmitter release can be highly variable: experimental data from electrophysiological, molecular and imaging studies have demonstrated that synaptic terminals can individually set their neurotransmitter release probability dynamically through local feedback regulation. Individual factors that contribute to the differences between facilitating and depressing synapses include those that determine the initial amount of transmitter released, which is generally higher for depressing than for facilitating synapses.Information processing in the brain is controlled by quantal release of neurotransmitters, a tightly regulated process. From ultrastructural analysis, it is known that presynaptic boutons along single axons differ in the number of vesicles docked at the active zone. The activity-dependent release of neurotransmitters at central synapses underpins brain function at the molecular, circuit, and behavioral level. Synaptic vesicle (SV) release probability (Pr), defined as the likelihood of an SV to fuse upon arrival of an action potential (AP), is one of the critical parameters in determining how synapses respond to changing patterns of activity. Pr is dynamically regulated by many interdependent factors, including presynaptic calcium homeostasis, the size of the readily releasable pool (RRP) of SVs, and SV heterogeneit. One of the most ubiquitous and important “activity signals” in the nervous system is changes in intracellular calcium mediated by voltage-dependent channels, and this influx is crucial for induction of many forms of synaptic and intrinsic plasticity. Once a change in activity is sensed, signaling through one or more transduction cascades must be increased or decreased, and changes in signaling through this cascade must result in altered AMPA receptor accumulation at synaptic sites. Another pathway implicated in synaptic scaling is activity-dependent expression of the immediate early gene Arc levels, that are bi-directionally regulated by the chronic changes in activity used to induce synaptic scaling in vitro.

Homeostatic plasticity stabilizes circuit function *in vivo* in a number of organisms and brain areas. Synaptic scaling has been most thoroughly studied *in vivo* in the visual system, using standard visual deprivation paradigms to generate an analog *in vivo* of activity-blockade in culture. Visual cortical microcircuitry can be modified in an activity-dependent manner in response to changes in sensory experience and there is mounting evidence that synaptic scaling plays important roles during various critical periods of visual system development. For example, during the second and third postnatal weeks when synaptogenesis is high, there is an inverse relationship between the frequency and amplitude of mEPSCs onto principal neurons in layer 4 of primary visual cortex (Layer 4 is the primary input layer to cortex, where the majority of thalamic inputs terminate). As the number of excitatory synapses rises ( increasing mEPSC frequency) and visual input increases, synaptic strength is reduced through an activity-dependent homeostatic mechanism. Neurons use homeostatic synaptic scaling to stabilize their firing rates in the face of developmental or learning-induced changes in drive, and contributes to the ability of central neuronal networks to “tune themselves up” and maintain stable function throughout life.Two general forms of synaptic plasticity that operate on different timescales contribute to the activity-dependent refinement of neural circuitry during development:

(1) long-term potentiation (LTP) and long-term depression (LTD), which involve rapid adjustments in the strengths of individual synapses in response to specific patterns of correlated synaptic activity, and

(2) homeostatic synaptic scaling, which entails uniform adjustments in the strength of all synapses on a cell in response to prolonged changes in the cell's electrical activity. Without homeostatic synaptic scaling, neural networks can become unstable and perform suboptimally.

Homeostatic plasticity encompasses a set of mechanisms to stabilize firing rates in neural circuits. The most widely studied form of homeostatic plasticity is upward synaptic scaling (upscaling), characterized by a multiplicative increase in the strength of excitatory synaptic inputs to a neuron as a compensatory response to chronic reductions in firing rate. While reduced spiking triggers upscaling, an alternative possibility is that reduced glutamatergic transmission generates this plasticity directly. Spiking and neurotransmission are tightly coupled.Neural networks need to maintain specific levels and patterns of spiking activity in order to function properly. As aberrant activity patterns develop following neural injury and disease, it is important to identify the triggers and mechanisms of plasticity that influence neural excitability. Homeostatic plasticity encompasses a set of mechanisms that act to maintain appropriate levels of spiking activity. Homeostatic synaptic scaling is a cell-autonomous, negative feedback mechanism that bidirectionally scales excitatory postsynaptic strengths to maintain [neuronal activity](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/neuronal-activity) within a set-point range. Two functionally distinct forms of synaptic plasticity, Hebbian long-term potentiation (LTP) and homeostatic synaptic scaling, are thought to cooperate to promote information storage and circuit refinement. Both arise through changes in the synaptic accumulation of AMPA receptors (AMPARs). Synaptic scaling and long-term potentiation (LTP) coexist at excitatory central synapses where they cooperate to maintain stability in neuronal output while selectively adjusting synaptic weights.

Two important functional distinctions between synaptic scaling and LTP are their temporal and spatial scales. Some forms of LTP induce rapid insertion of AMPARs into the synaptic membrane on a time scale of minutes, whereas synaptic scaling gradually and cumulatively increases synaptic AMPARs over a period of many hours. Spatially, LTP can be induced in a synapse-specific manner in response to local synaptic activation. LTP and synaptic scaling probably use distinct receptor-trafficking pathways.Synaptic scaling was first identified in cultured neocortical neurons, where it was observed that perturbing network activity generated compensatory changes in synaptic strength that were in the right direction to restore average firing rates to baseline values. Pharmacological manipulations of activity are able to induce bidirectional compensatory changes in the unit strength of glutamatergic synapses, which can be measured by recording miniature excitatory postsynaptic currents (mEPSCs, or “minis”) that represent the postsynaptic response to release of individual vesicles of neurotransmitters. By measuring minis arising from many synapses onto the same neuron, it was observed that modulating network activity induced uniform increases or decreases in the entire mini amplitude distribution, in effect scaling postsynaptic strength up or down.

Perturbations in network activity can be sensed by individual neurons as changes in their own firing, local changes in receptor activation, or changes in release of secreted factors. Although some forms of homeostatic plasticity are triggered by local signaling through secreted factors there is strong evidence that synaptic scaling is a cell-autonomous process induced by changes in a neuron’s own firing. Like scaling up, scaling down in response to elevated network activity is a cell-autonomous function of postsynaptic firing, and involves enhanced calcium influx gene transcription. In theory homeostatic plasticity mechanisms exist at the network level, and operate through the activity-dependent release of secreted factors that act at a number of sites within the network to regulate the excitation/inhibition (E/I) balance.Neural circuits are composed of many excitatory and inhibitory cell types interconnected in highly specific ways. Although in neocortical networks the net effects of changes in excitation and inhibition appear to be homeostatic different classes of inhibitory synapse are regulated differently by lowered activity. Not all excitatory neurons in cortical networks express synaptic scaling.

Homeostatic plasticity is a vital aspect of in vivo circuit function at many stages of development. For example, during embryonic and early postnatal development, homeostatic mechanisms can ensure that spontaneous activity is present in developing spinal circuits where such activity is vital for driving proper circuit connectivity, In visual cortical microcircuits the locus of homeostatic plasticity changes as the circuit matures synapses with the selective modification of inhibitory networks, so that there is an overall rebalancing of excitation and inhibition. Neurons and networks use a family of homeostatic synaptic plasticity mechanisms to stabilize firing rates in the face of developmental or learning-induced changes in drive, and this contributes to the ability of central neuronal networks to maintain stable function and enables networks to maintain the specificity of synaptic changes that encode information. Synapses undergo rapid activity-dependent plasticity to store information, which when left uncompensated can lead to destabilization of neural function. Homeostatic changes, which operate at a slower time scale, are required to maintain stability of neural networks. While there are many mechanisms that can endow homeostatic control, sliding threshold and synaptic scaling are unique in that they operate by providing homeostatic control of synaptic strength. The former mechanism operates by adjusting the threshold for synaptic plasticity, while the latter mechanism directly alters the gain of synapses, In an intact circuit, neurons receive distinct set of inputs across their dendritic tree which carry unique information. Homeostatic synaptic plasticity *in vivo* needs to operate without compromising processing of these distinct set of inputs to preserve information processing while maintaining network stability. Synaptic scaling is another popular model that provides homeostasis by adjusting the synaptic gain. While the sliding threshold model was initially proposed to explain the development of neural response selectivity and experience-dependent cortical plasticity, the premise of synaptic scaling was to explain stability of network activity propagation and firing rate homeostasis. Prolonged inactivity leads to upscaling of excitatory synapses, while prolonged increase in activity downscales them to maintain overall average firing rate.

While both sliding threshold and synaptic scaling can provide similar homeostatic control by regulating synaptic strength, they differ in one key element. Sliding threshold model operates by altering the induction threshold for LTP/LTD. Even if the synaptic modification threshold has changed based on integrated past activity, if there is insufficient neural activity through any of the synapses, there will be no change in synaptic gain and synaptic scaling can occur without neural activity. Sliding threshold mediated homeostatic adaptation can easily implement input-specificity. Inputs that exhibit activity above the threshold produce potentiation, those falling below depress, and inputs with minimal activity or activity at the threshold do not change. Such input-specific homeostatic adaptation allows the circuit to preferentially process currently active inputs despite overall activity changes. The cortical networks can be dynamically reconfigured for processing the most relevant information in the context of overall activity in the circuit. Input-specific homeostatic plasticity is more prevalent in mature cortex. It is widely agreed that synaptic scaling involves postsynaptic changes in receptor accumulation, but under some circumstances additional presynaptic changes can also be recruited. In addition to forms of homeostatic plasticity such as synaptic scaling that are induced in a global manner as a function of postsynaptic firing, there is also evidence that local or quasi-local changes in synaptic signaling can induce homeostatic changes in synaptic strength. A truly local form of plasticity would be induced at an individual synapse as a function of changes in presynaptic release and/or postsynaptic receptor activation at an individual synaptic site.Throughout life, neural circuits change their connectivity, especially during development, when neurons extend and retract dendrites and axons, and form and eliminate synapses. In spite of their changing connectivity, neural circuits maintain relatively constant activity levels and achieve functional stability by homeostatic plasticity, which equipoises intrinsic excitability and synaptic strength, balances network excitation and inhibition, and coordinates changes in circuit connectivity.

Nervous systems face a constant challenge: how to maintain flexibility and stability at the same time. Neural circuits must stay flexible to allow for changes in connectivity and synaptic strength during development and learning. As changes in connectivity push neural circuits away from equilibrium, they need to maintain activity within a working range and avoid extremes of quiescence and saturation. Functional stability is maintained by homeostatic plasticity, which is defined broadly as a set of neuronal changes that restore activity to a set point following perturbation.Synaptic plasticity is generally considered within the context of synaptic adaptations where, synaptic strength and subsequent neuronal activity are modified in the direction of prior “conditioning” stimulation. For instance, in classical long-term potentiation (LTP) the strong stimulation or pairing—coincidence of presynaptic activation with postsynaptic depolarization—results in strengthening of a particular synapse. In contrast to postsynaptic scaling, homeostatic or negative feedback responses to chronic alterations in network activity may also elicit presynaptic forms of plasticity . These presynaptic modifications typically occur via retrograde signaling targeting presynaptic neurotransmitter release machinery following postsynaptic signal transduction events. presynaptic alterations in synaptic strength—largely based on changes in presynaptic release probability—do not follow the mathematical “scaling” rule as they do not necessarily preserve the relative strengths of postsynaptic efficacy among a set of synapses but rather alter the dynamics of neurotransmission during bursts of activity. Due to this distinction between pre- versus postsynaptic forms of homeostatic plasticity, alterations in presynaptic release probability do not only up- or downregulate synaptic strength but also alter information processing dynamics of a synapse.

While direct regulation of ion channel properties may provide a means for plasticity independent of synaptic strength, studies have also demonstrated that synaptic strength can be regulated directly independent of potential changes in neuronal action potential firing. Alterations in spontaneous neurotransmitter release or sensing neurotransmitter input, independent of presynaptic action potentials, Show an autonomous role for spontaneous release, rather than activity per se, in the regulation of synaptic strength. Neuronal and synaptic signaling have been associated with activity. Increases in activity levels typically give rise to elevations in local or global calcium signals which can exert effects on signal transduction pathways. Homeostatic compensations are presented as relatively slow processes developing in response to prolonged perturbations of neuronal activity and relying on the synthesis of new proteins that regulate key physiological parameters, such as synaptic efficacy, synapse number and membrane excitability. Besides synapse-specific mechanisms, evidence point to both permissive and instructive roles of the extracellular matrix (ECM) and glial cells in homeostatic plasticity. Neuronal networks can be viewed as learning and memory storage devices. They are highly plastic changing the way they process information in response to external stimuli also tenacious with many neuronal networks retaining their functional identity over many years.Expression of genes involved in synaptic and structural plasticity as part of a neuronal intrinsic excitability is determined by the density, distribution, and function of ion channels, and controls how synaptic inputs are converted into action potential outputs. Multiple ion channels in the same neuron can balance each other to stabilize activity. Detailed examination of the distribution of ion channels revealed an important role of the axon-initial-segment (AIS) in intrinsic homeostatic plasticity. Changes in length and location of the AIS, a specialized region with clusters of voltage-gated Na+ and K+ channels involved in spike generation, can counter the effects of sensory deprivation or photostimulation Homeostatic plasticity can regulate synaptic strength pre- and postsynaptically, and its dominant expression site can shift during development.

Homeostatic plasticity can stabilize the activity of individual neurons. Neurons connect to each other in a cell-type-specific manner, forming circuits that perform specific functions. Network activity is determined by the ratio of excitation and inhibition (E/I ratio). In response to perturbations, developing circuits can differentially adjust inhibitory and excitatory connectivity to alter the E/I ratio and restore activity. In addition to regulating excitatory and inhibitory synapse strength and number, homeostatic plasticity can switch the transmitter phenotype of neurons from glutamate to GABA or vice versa to adjust the E/I ratio of developing circuits. Homeostatic regulation of excitatory connectivity can also be cell type specific.Throughout the nervous system, developing circuits spontaneously generate activity patterns that refine their connectivity. Before eye opening, waves of activity originating in the retina propagate through the visual system and dominate activity up to primary visual cortex. Retinal waves mature in three stages (I-III), in which different circuit mechanisms generate distinct activity patterns that serve specific functions in visual system refinement. Developing circuits undergo profound changes in connectivity that threaten to destabilize their activity.“plasticity transcriptome” (plasticity-related genes such as Arcadlin RB-3 Syt4 Nrxn3, Adrb1, Grm6, Chrm4, Chrna4, Grin2D, Gad2) associated with long-term memory, induce and consolidate functional and structural long-term changes of neuronal connectivity following learning. Long-term storage of memory (LTM) hypothesized an “intramolecular autocatalytic” reaction, a molecular mechanism that once activated persists in a self-sustaining manner and its trace can be associated with a discrete subset of neurons, reminiscent of engram cells. Systems consolidation progressively relies on cortical areas and less on the hippocampus in a process that involves delayed maturation of cortical neurons and mediated by hippocampal sharp-wave ripples (SWR). They are associated with highly synchronous neural firing of subsecond duration and support both memory consolidation and memory retrieval.

Memories are encoded in sparse neural ensembles distributed across the brain. During the post-encoding period, often during sleep, many of the cells that were active during encoding are reactivated, supporting consolidation of this memory. During memory recall, many of the same cells that were active during encoding and reactivated during consolidation are reactivated during recall. These ensembles of cells have been referred to as the memory engram cells, stably representing a specific memory.To be remembered, learned episodic or semantic information must be stabilized and stored in the long term through a process known as consolidation which involves synaptic and system changes occurring over varying time scales. Synaptic consolidation requires RNA production and [protein synthesis](https://www.sciencedirect.com/topics/neuroscience/protein-biosynthesis), molecular changes that lead to more efficient synaptic coupling and involves reorganization of memory traces across brain regions as the consolidation progress.

**Theories of consolidation**.

A. **Standard Consolidation Theory.** This view proposes that memories are initially encoded in the hippocampus. However, memory traces are gradually transferred over time to neocortical regions, where they consolidate. This theory suggests uniform mechanisms for both episodic and semantic memories.

B. **Indexing Theory.** This view proposes that the cortical activity patterns are encoded as an index of experience. Over time, the neurons representing this index consolidate by forming enhanced synaptic connections.

C. **Multiple Trace Theory.** This view proposes that memory traces are simultaneously formed in the cortex. Cortical semantic memories tend to evolve into more abstract forms as time progreses, allowing for the retrieval of the semantic gist

D. **Complementary Learning Systems Theory.** This view suggests that initial encoding and consolidation occur exclusively in the HC. As these HC memory traces stabilize through enhanced synaptic connections, they are transferred to the cortex. Cortical engrams are encoded as schemas, capable of expanding through experience and retrievable .

A critical feature of [episodic memories](https://www.sciencedirect.com/topics/neuroscience/episodic-memory) is their dependence on contextual information. This feature emphasizes the notion that facts and events within our experiences become integrated within a contextual. Engram cells can switch valence in some regions. Reactivating silent engrams has proven effective in rescuing memory even under normal conditions. Activation of engram cells served to recover object location memories following sleep deprivation, a procedure that impairs memory. Substantial evidence points to the pivotal involvement of [synaptic plasticity](https://www.sciencedirect.com/topics/neuroscience/synaptic-plasticity) in stabilizing neocortical engrams and memory, mirroring its role in the stability of subcortical engrams During sleep, the brain undergoes reorganization of neuronal activity, closely linked to memory consolidation. An integral memory engram may consist of preferential connectivity between engram cell ensembles distributed across multiple brain regions.

Memory is a fundamental function of many living systems. It allows us to retain a history of our past experiences—our past interactions with the world and the consequences of those interactions. And this history guides our future interactions with the world; the past tells us what should be avoided and what might be worth our while. The world is an ever-changing environment, and humans have a remarkable ability to flexibly regulate their memories which are constantly being formed as we have new experiences, and filter which of these experiences should be stored, which past memories might now be obsolete and should be updated, which memories should be forgotten; and we use our memories to inform the way that we learn in the future. This rich memory system is central to survival, and it arguably defines our life experience. The formation of a memory begins during an experience that initially drives robust neuronal activity to initiate the formation of a memory, a process of memory consolidation occurs for the hours thereafter whereby the experience is stored in the brain for future retrieval. This process of long-term storage requires that long-term changes are made in the brain to store the information related to the experience. On a longer timescale, memories consolidate across weeks to years, and this distinct mechanism has been termed systems consolidation. Memories are rapidly formed through synaptic plasticity in the hippocampus, and this memory is transferred to cortical areas across weeks. This transformation is accompanied by memories becoming less specific and more gist-like . Another form of memory updating is memory reconsolidation that refers to a state shortly after memory recall, during which memories are malleable and can be updated.While many salient memories that we store last a lifetime, many memories that we once formed are later forgotten. As we accumulate memories across our lives, we organize them into larger umbrellas of memories into which we categorize new memories. This has been termed schema learning. We experience the world continuously across time, and even when two memories that are formed adjacent in time have no relation to one another, we may be more likely to recall those two memories together than two memories that occurred distant in time.

Memory formation, storage, and recall constitute the essence of human nature. The search for the mechanisms underlying learning and memory has revealed the importance of a number of molecular and cellular processes, such as activity-dependent gene expression, intracellular signaling cascades, and synaptic plasticity. The long-lasting attempts to characterize memory localization resulted in identification of specific neuronal populations—so-called engrams—that provide a physical location for the storage and retrieval of memory traces. The restructuring of hippocampal–cortical networks through synaptic plasticity is necessary for the formation of new episodic memories. Memory, defined as an experience-dependent alteration in behavior that persists beyond the environmental stimuli that produced it is conceptualized as a multi-staged process that includes encoding, consolidation, retrieval, and forgetting. Mechanistically interpreting memory in the brain is facilitated by understanding the neural underpinnings of each of these stages independently, as well as how these neural elements interrelate across stages. The engram can be viewed as the physical change that occurred in the nervous system in response to a learned experience, which can later mediate instantiation of the corresponding memory. Engram neurons are typically defined as the neurons that are preferentially involved in the the encoding, consolidation, and retrieval of a particular memory

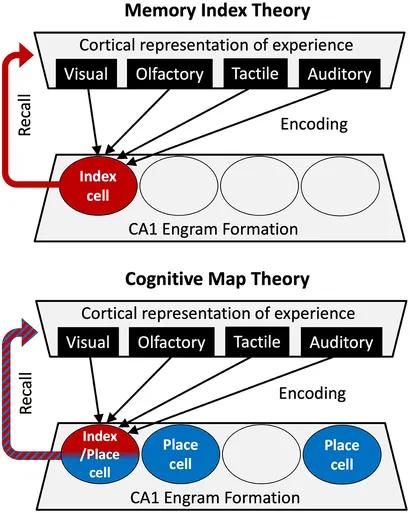
The probability of forming a long-term hippocampal-dependent memory increases upon repeated behavioural exposures to the learning event, and repeated internal representations of the learning event also occur during behaviourally ‘offline’ periods. During these offline times, such as sleep or quiet wakefulness, patterns of activity among recently active hippocampal neurons is spontaneously replayed. Such replay events occur in either a forward or backward direction in a temporally-compressed format – upwards of 20x faster than occurred during the initial learning experience. Hippocampal replay events occur selectively during sharp wave ripples (a form of high frequency network oscillation) and drive memory consolidation. For example, optogenetic increase of sharp wave ripple duration improves consolidation of the corresponding memory and selective disruption of replay prevents consolidation of the corresponding memory.Memory replay doesn’t simply reflect the strongest representation rising to the surface, but occurs for memories most in need of consolidation (i.e., those most at risk degradation). In accordance with this, targeted reactivation of fear-conditioning-induced lateral amygdala engram neurons during consolidation increases subsequent memory strength. These fear memory engram neurons are preferentially reactivated during sleep, and optogenetically inhibiting their reactivation during sleep (but not later waking periods) prevents memory consolidation. These findings converge on the idea that internally generated replay strengthens recently formed memories. Hippocampal-dependent memories undergo systems-level consolidation. In the days, weeks, and months (and potentially years, in humans) following synaptic consolidation, the initially hippocampal-dependent component of memory undergoes extreme reorganization and redistribution such that it can be stored and expressed in a hippocampal-independent, mPFC-dependent format.

This spatial reorganization of memory is known as systems consolidation. While hippocampal and mPFC-neocortical ensembles representing the same experience can co-exist in the brain, the phenomenological (or subjective) qualities of the memory depend on which neuronal ensemble is activated. Hippocampal-dependent memories are context-specific and detailed (i.e., episodic), whereas mPFC-dependent memories are associated with a more gist-like quality. This is especially true following systems consolidation, after which mPFC ensembles come to represent commonalities among individual experience to generate a more schematized or generalized representation. Hippocampal engram reactivation drives systems consolidation. In contrast to hippocampal-dependent memories that consolidate within hours, mPFC-dependent memories generally take weeks to consolidate and contribute to memory storage and retrieval. Structurally, mPFC engram neurons take multiple weeks to display learning-mediated increases in dendritic spine density, as well as increased synapse-specific strengthening between mPFC engram neurons

The transformation of a short-term, labile memory into one that persists long-term requires synaptic and systems consolidation – a process that occurs preferentially in neurons active during memory encoding. Such processes take engram neurons involved in the encoding of memory, and promote connections of both local and long-range ensembles. Such spatially and temporally dynamic processing enables memory persistence via evolving activity that can embody distinct aspects of memory.If the neurons active in response to learning form a critical and enduring component of the memory, then selectively silencing these neurons should disrupt retrieval of the corresponding memory. Activating engram neurons promotes memory retrieval. Simultaneous activation of engram neurons across multiple brain regions promotes stronger memory retrieval than activation of engram neurons within a single neuron region. That memory retrieval induced by activating engram neurons has been widely replicated across neural regions and behavioural paradigms (e.g., fear conditioning ; conditioned place avoidance and preference, go/no-go licking, inhibitory avoidance object location memory, social preference memory.

Memory retrieval can promote a transient increase in engram excitability that causally drives improved memory performance. According to the encoding specificity principle, memory retrieval success is dictated by the extent to which cues present at retrieval match that those present during encoding. Forgetting is viewed as the lack of behavioural expression of a memory, which could be otherwise successfully recalled and expressed on an earlier occasion and can occur because the memory is no longer *available* (i.e., complete engram degradation; a storage deficit) or because it is not currently *accessible* (i.e., a retrieval deficit). In order for learning to ocur, an experience must result in enduring changes in anatomical connections and physiological processes within the brain. Rapid and efficient recall of this experience (e.g. an episodic memory) depends on these anatomic and physiologic changes. The sparse ensemble of neurons across multiple brain regions manifesting these learning –induced changes is called engram. The connected and unified engram complex is interchangeable with memory trace and recognized as the sunstance for episodic memories in the brain, an assembly of fcells , which are :

1. Activated during experience
2. Undergo structural and functional modifications as a result
3. Reactivated upon recall of the experience.
4. The hippocampus is essential for formaion of episodic memories.



**Figure85.**  Comparing roles for hippocampal CA1 in the Memory Index theory **(Top)** and Cognitive Map theory **(Bottom)**. In the Memory Index theory, the CA1 engram cells (red index cell) merely integrate upstream representations of an experience to serve as an index for retrieval of the experience. In the Cognitive Map theory, the indexing of the experience (red cell) occurs on a substratum that encodes space (blue place cells), providing a context-based anchor for episodic memories.

Neuronal allocation describes the phenomenon by which a specific population of neurons, but not others within the same network, are recruited to encode an experience as memory. The neuronal allocation perspective gives high importance to neuronal properties in determining memory engram allocation—neurons that are more excitable at the time of learning become the bearers of the memory. If memory encoding is at neuronal excitability level only, then erasure of one particular memory ( silencing of the engram ensemble for this memory) will cause significant distortion/impairment of other memory engrams. Selective erasure of one memory without affecting other memories similar in nature has been experimentally demonstrated Synaptic allocation refers to the mechanisms that determine how synapses are involved in storing specific memories. Most neurons have hundreds to thousands of synapses (e.g., hippocampal pyramidal neurons). An individual neuron may recruit 15–20% of all its synapses to encode a specific memory. The spatial aspect concerns the spatial distribution of synapses involved in encoding a specific memory. The hallmark feature of a memory trace is its relatively long-lasting nature. To support an enduring memory, activation of gene transcription and protein synthesis must occur in the cell nucleus (transcription) and the soma (protein synthesis). Synaptic plasticity is required for successful learning, but comes at the cost of potentially degrading information already stored in the circuit (i.e. the plasticity-stability dilemma. Given sufficient synaptic remodeling of an engram-specific neuronal ensemble, forgetting is unavoidable: there is an inevitable tipping point beyond which information stored in the ensemble will be lost (i.e., unless another set of synapses takes over the memory representation.Any significant alteration to the synaptic connectivity within which an engram is embedded should lead to forgetting of the corresponding memory. Post-learning hippocampal neurogenesis is a powerful means through which hippocampal circuitry is remodeled and altered: as new dentate gyrus granule neurons mature, they infiltrate and reconfigure surrounding circuitry by forming connections with both presynaptic and post-synaptic partners. As newborn neurons integrate into these pre-established circuits, their synaptic connections exist alongside and, in some cases, replace established synaptic connections.

Microglia are the brain’s resident macrophage and immune cells. These cells also regulate synapse dynamics and modulate rates of forgetting. Specifically, microglia-mediated synapse removal both decreases dentate gyrus engram reactivation and promotes forgetting of hippocampal-dependent memories. Suppressing microglia-mediated synapse elimination further evidence that neurogenesis induces forgetting via synaptic remodeling of hippocampal circuitry.Astrocytes also regulate synapse dynamics via activity-dependent elimination of excitatory synapses, resulting in forgetting. Synaptic depotentiation in response to ongoing neural activity (e.g., ordinary mental exertion) is considered one of the main causes of forgetting . Memories are retrievable in situations where one might classically assume that the engram has degraded to the point where it is no longer available. For example, memories ‘lost’ to infantile amnesia and neurogenesis-induced forgetting can be recovered by optogenetic or chemogenetic stimulation of the dentate gyrus engram. Forgetting is the result of failed memory retrieval, as opposed to memory erasure. As synaptic changes in engram circuitry accumulate, so too does the probability of forgetting. Synaptic remodeling of engram circuitry represents a general mechanism of forgetting and occurs from a variety of sources, including depotentiation of existing synapses, new synapses driven by ongoing neurogenesis, and synaptic elimination by non-neuronal cells. By disrupting the properties of engram synapses strengthened during early memory stages, circuit remodeling decreases the probability of engram reactivation and promotes forgetting.

Engram cells are conceived as neurons that

(a) are active during initial learning,

(b) display some persistent physical change in response to learning, and

(c) are reactivated during (and required for) memory retrieval.

According to this strict definition, no new neurons are added or removed from the engram

1. ***Existence of non-neuronal engram cells***. the engram field places a heavy, almost exclusive emphasis on neuronal engram cells. Non-neuronal engrams exist, with astrocytes being a prime candidate. They play an active role in information process, including regulating synaptic function, circuit connectivity, and memory retrieval. Activation of astrocytes during memory encoding improves memory retrieval without altering basal synaptic transmission.
2. ***Neural inactivity does not imply mnemonic passivity***. The anterodorsal thalamic nucleus which is necessary for the retrieval of recent, but not remote, contextual fear memory needs to be actively inhibited at remote timepoints for memory retrieval to succeed. This inhibition is necessary for content-specific memory retrieval success. As re-activating neurons that were active during encoding promotes memory retrieval, re-inhibiting neurons that were actively inhibited during encoding can also promote memory retrieval.
3. ***Different neurons often underlie different stages of memory processing***. Engram neurons are typically defined as neurons that were active during both encoding and retrieval of memory. Emerging evidence has illustrated, that some neurons play a critical role in memory encoding but do not have a similarly critical role in memory retrieval. There are neurons that play no clear role in memory encoding, but are recruited into the engram later during consolidation and contribute significantly to memory retrieval. A less strict definition of the engram may serve to help to amalgamate these complementary roles, incorporating ‘*encoding* engram neurons’ (i.e., neurons that are essential for memory encoding only), ‘*retrieval* engram neurons’ (i.e., neurons that are essential for memory retrieval only), and ‘*reactivated* engram neurons’ (i.e., neurons essential to both encoding and retrieval). Such terminology more accurately captures the dynamic nature of memory and better highlights the role different engram neurons play in different stages of memory processing.
4. ***‘Encoding’ engram reactivation is an incomplete model of memory retrieval***. Memory is an inherently constructive process. Perception of an experience and memory retrieval of that experience are fundamentally distinct phenomena, with distinct psychological properties, engaging distinct neural circuitry.

Memory which is the ability to use the past in service of the present or future is central to our everyday lives and defines who we are. Without it, we are condemned to an eternal present. That memory persists after an experience suggests that an internal representation of this experience is stored in the brain and that later this representation can be reconstructed and used. An “engram” refers to the enduring offline physical and/or chemical changes that are elicited by learning and underlie the newly formed memory associations. “Engram cells” are populations of cells that constitute critical cellular components of a given engram:

1. activated by a learning experience,
2. physically or chemically modified by the learning experience, and
3. reactivated by subsequent presentation of the stimuli present at the learning experience resulting in memory retrieval.

An “engram cell ensemble” refers to the collection of engram cells localized within a brain region. Engram cell ensembles in each brain region are connected, forming an “engram complex,” which is the entire brainwide engram supporting a memory that is stored in sets of engram cell ensembles in different brain regions connected via an engram cell pathway.Artificial optogenetic or chemogenetic reactivation of tagged or allocated engram cells across several brain regions induced memory expression without external sensory retrieval cues in a variety of tasks. During natural memory retrieval, the sensory conditioned stimulus (e.g., the training context) reactivate engram cells to induce memory retrieval. Engrams may become damaged, such that a memory becomes forever unavailable or temporarily inaccessible, such that the engram still exists but cannot be retrieved by natural means. Silent engrams that cannot be retrieved by natural retrieval cues but can be retrieved with direct optogenetic stimulation. Inhibiting protein synthesis before or immediately after an experience induces amnesia and block cellular consolidation, that refers to the relatively fast process of memory stabilization to involve the expression of genes necessary to strengthen synapses. By contrast, systems consolidation refers to the slower, time-dependent reorganization of memories over distributed brain circuits. The representation of a memory in the brain may change with time and circumstance. Memories may become less precise and more generalized with time. According to memory transformation theory, changes in the nature and quality of memories correspond to changes in neural representations, with hippocampal-dependent context-specific detailed memories transforming into gist-like schematic memories represented in cortical structures over time. Engram silencing may represent a continuum of a natural state of an engram. Different processes may mediate distinct engram states. An engram may be

1. unavailable (neither natural conditioned stimuli nor artificial reactivation induces memory expression),
2. silenced (only artificial reactivation is sufficient to induce memory expression),
3. dormant or latent, or
4. active (currently being retrieved).

With time and experience, memories undergo a process of reorganization that involves different neuronal networks, known as systems consolidation. Over the course of systems consolidation, there is a switch from a reliance on detailed episodic memories to generalized schematic memories. This switch is referred to as “memory transformation a process in which as time passes, memories transform from a highly detailed state to a more gist-like state.Theories of memory transformation speak to its advantages in terms of reducing memory interference, increasing memory robustness, and building models of the environment. Over short time periods, the natural world is highly correlated with itself, whereas over longer time periods, short-term correlations give way to larger statistical patterns. For example, if a bird discovers fruit on a tree, then returns to the same tree an hour later, it is likely to find more. In contrast, if the bird returns to the same tree a month later all of the fruit may be gone, making the memory for that individual tree less useful. Combining many such memories provides the bird with general knowledge of where food may typically be found.

Two types of memory (specific vs general) may be more or less useful depending on the amount of time that has passed.The brain relies on multiple systems to guide behavior including those that capture general patterns (schematic memories) and those that capture specific experiences (episodic memories). Humans and animals rely on recent episodic memories to make decisions, but episodic memories give way to schematic memories over time as part of a memory reorganization process referred to as “schematization” or “memory transformation”. The benefits of this episodic to schematic transformation are assumed to be reduced memory interference and the formation of a more stable memory. Some computational work has explored the idea that episodic to schematic transitions could be beneficial for guiding because there is a performance improvement in using episodic memories soon after a novel experience and schematic memories after more experience. This considers only the accumulation of data, and not the passage of time. In the real world, there are periods of data accumulation (e.g., foraging) and periods without data (e.g., rest, migration), and memory transformation occurs regardless of whether data are being accumulated or not. Our memories are not simply a static collection of individual snapshots of meaningful experiences, but rather represent integrated memories across experiences. Neural processes underlying consolidation need to *transform* as well as prioritize memory traces. In addition to prioritization, an adaptive memory system also necessitates mechanisms for transformation.Memory consolidation, the process of stabilizing new memories for the long-term, involving mechanisms that can both prioritize and transform new experiences refers to mechanisms at two different levels: cellular consolidation – changes in the structure of the synapse, and systems-level consolidation – changes in the distribution of memory representations *across* brain regions. Selectivity is critical to adaptive memories,

Emotional information is the clearest example of the type of goal-relevant experiences targeted by consolidation. Intrinsically emotional information, such as highly arousing images or words, is remembered better compared to neutral information. This emotional memory benefit depends on processes that occur during consolidation, as memory performance diverges for emotional and neutral information most strongly after a delay and selectively renders emotional stimuli more resistant to forgetting compared to neutral stimuli. Similar selective memory benefits have also been reported for neutral information encoded in a heightened motivational state. An extrinsic goal state can shift the prioritization of otherwise mundane information, as it is also critical to encode the features that lead to reward attainment or avoidance of threats. In the reward domain, studies have shown that extrinsic reward motivation leads to superior delayed memory performance for neutral stimuli directly associated with high-value stimuli or encountered in a high-reward state. Motivation to avoid the threat of punishment an aversive shock, leads to selective delay-dependent memory enhancements. The prioritization of neutral information in long-term memory via the association with positive or negative events links the literatures on emotional enhancement of episodic memory with associative learning paradigms such as Pavlovian conditioning. These findings help to mitigate the potential confounds that arise when considering intrinsically arousing stimuli, as memory benefits in these cases could be driven by stimulus specific factors, such as limited thematic content for emotional stimulus sets, irrespective of selective consolidation The coordinated replay of memories in the hippocampus and areas of the cortex are supported by the hippocampal-cortical dialogue achieved through the hierarchical temporal coupling between sharp wave ripples (80–100 Hz), which support replay events with more global slow oscillations (< 1 Hz) and thalamocortical sleep spindles (11–16 Hz) . Spindles in particular have been related to measures of the cross-regional dialogue, including hippocampal-cortical functional connectivity and the reactivation of memory traces.

Sleep-dependent mechanisms support the prioritization and transformation of goal-relevant information central to adaptive memory consolidation. A period of sleep, but not an equal wake period, benefits the selective retention of emotional and rewarded information in memory. Dopamine signaling may particularly support this selectivity, as pharmacologically enhancing dopamine activity can spread retention benefits to low-reward memories during sleep. In line with sleep benefiting the prioritization of goal-relevant information, studies have shown specific benefits of sleep for the retention of task goals and content determined to be relevant for future use. Spindle activity is sensitive to the goal relevance of the prior experience when newly learned information is explicitly instructed to be of future use. These oscillations may dynamically reflect the need to consolidate relevant learned information, and act as a critical mechanism for adaptive consolidation. Spindle density during post-encoding sleep is also related to increased overlap in the representational pattern amongst recently learned information, suggesting a role in the organization of memory representations. These effects may reflect the active mechanisms during sleep that promote adaptive functions of systems consolidation.Sleep is a period that promotes the adaptive forgetting of superfluous or redundant details accumulated throughout the day that are not deemed significant and do not necessitate preservation in long-term episodic memory either through direct experience or through temporal association with meaningful experiences. Sleep may be the optimal time to extract generalized knowledge across waking experiences tagged with salience, to integrate information into existing frameworks (schemas), and to extract regularities to guide future goal-directed behavior to related cues and situations.

Human neuroimaging research has enhanced functional coupling between the hippocampus and areas of the cortex following a learning experience in a manner that predicts later memory performance – particularly with regions previously engaged during learning and provided evidence and support for the idea that memories are stabilized through the cross-regional interactions of the hippocampal-cortical dialogue critical to systems consolidation mechanisms. Reports have found increased hippocampal-cortical functional coupling after a period of sleep or short delay and found that such functional coupling enhancements are related to the density of sleep spindles during the prior night of sleep, specifically for memories initially learned prior to the sleep period. Research on functional coupling changes suggest the hippocampal-cortical dialogue facilitates the retention of goal-relevant material. Conscious memory for a new experience is initially dependent on information stored in both the hippocampus and neocortex. Systems consolidation is the process by which the hippocampus guides the reorganization of the information stored in the neocortex such that it eventually becomes independent of the hippocampus that guides the reorganization of the information stored in neocortex to establish long-term memories.Memory consolidation refers to the process by which a temporary, labile memory is transformed into a more stable, long-lasting form. Systems consolidation is accurately, described as the process by which memories, initially dependent on the hippocampus, are reorganized as time passes. By this process, the hippocampus gradually becomes less important for storage and retrieval, and a more permanent memory develops in distributed regions of the neocortex. The idea is not that memory is literally transferred from the hippocampus to the neocortex, for information is encoded in the neocortex as well as in hippocampus at the time of learning.

The idea is that gradual changes in the neocortex, beginning at the time of learning, establish stable long-term memory by increasing the complexity, distribution, and connectivity among multiple cortical regions. Memory is reconstructive and vulnerable to error, as in false remembering under some conditions. Long-term memory can transiently return to a labile state (then gradually stabilize), a phenomenon termed reconsolidation. The rate of consolidation can be influenced by the amount of prior knowledge that is available about the material to be learned. Neurocomputational models of consolidation describe how the acquisition of new knowledge proceeds. Elements of information are first stored in a fast-learning hippocampal system. This information directs the training of a “slow learning” neocortex, whereby the hippocampus gradually guides the development of connections between the multiple cortical regions that are active at the time of learning and represent the memory. Training of the neocortex by the hippocampus (termed “interleaved” training) allows new information to be assimilated into neocortical networks with a minimum of interference. In simulations rapid learning of new information, which is inconsistent with prior knowledge, is shown to cause interference and disrupt previously established representations (“catastrophic interference”). The gradual incorporation of information into the neocortex during consolidation avoids this problem.

Memory consolidation refers to the transformation over time of experience-dependent internal representations and their neurobiological underpinnings. The process is assumed to be embodied in synaptic and cellular modifications at brain circuits in which the memory is initially encoded and proceeds by recurrent reactivations, both during wakefulness and during sleep, culminating in the distribution of information to additional locales and integration of new information into existing knowledge.Consolidation is commonly addressed at two levels of description and analysis, the cellular/synaptic level and the brain systems level. “Synaptic consolidation” (also cellular consolidation, local consolidation) refers to the post-encoding transformation of information into a long-term form at local synaptic and cellular nodes in the [neural circuit](https://www.sciencedirect.com/topics/neuroscience/neural-circuit) that encodes the memory. The current central dogma of synaptic consolidation is that it involves stimulus (“teacher”)-induced activation of [intracellular signaling](https://www.sciencedirect.com/topics/neuroscience/intracellular-signaling) cascades, resulting in postranslational modifications, modulation of gene expression and synthesis of gene products that alter [synaptic efficacy](https://www.sciencedirect.com/topics/neuroscience/synaptic-efficacy).

Synaptic consolidation is traditionally assumed to draw to a close within hours of its initiation, at the end of which it becomes resistant to a number of agents that otherwise can prevent the memory from being converted into the long-term form (“amnesic agents,” among them distracting stimuli and pharmacological agents). “Systems consolidation” refers to the post-encoding time-dependent reorganization of long-term memory (LTM) representations over distributed brain circuits. It is assumed that systems consolidation involves recurrent waves of synaptic consolidation in the new brain locales that receive new or reprocessed experience-dependent information, i.e., synaptic consolidation could be regarded as subroutines in systems consolidation. Systems consolidation may last days to months and even years depending on the memory system and the task. The conventional taxonomy of LTM systems distinguishes between [declarative memory](https://www.sciencedirect.com/topics/neuroscience/declarative-memory), which is memory for facts (semantic) or events (episodic) that requires explicit awareness for retrieval, and non-declarative memory, a collection of memory faculties that do not require such awareness for retrieval.

[Acetylcholine](https://www.sciencedirect.com/topics/neuroscience/acetylcholine) has been identified as one of the key determinants of [information processing](https://www.sciencedirect.com/topics/neuroscience/information-processing) and flow in and out of the hippocampus. [Cholinergic activity](https://www.sciencedirect.com/topics/neuroscience/cholinergic-activity) is high during wakefulness. Neurons that are relatively more excitable than their neighbors at the time of an experience are more likely to be allocated to the engram supporting the memory of that experience. Increased excitability in engram cells is maintained for several hours after an experience. If a related experience occurs in this time window, these same (or overlapping) engram cells are more excitable than their neighbors and thus coallocated to the engram supporting the memory of the second experience. Acetylcholine which is released during vigilance states by long range neuronal fibers, also activates astrocyte acetylcholine receptors and promotes astrocyte-mediated neuronal cross-talk. Acetylcholine in concert with noradrenaline maintain brain-wide oscillations to synchronize different brain areas and to insure correct cognitive performance and sensory perception. “generalized functional astrocytic syncytium” that received strong support by the observation of intercellular calcium waves spreading to numerous cells by traveling through gap junctions embodies the basic structure of memory storage in the brain (hard disc). Gap junction coupling within this syncytium fulfils a neuroprotective role to maintain a physiological membrane potential that delays or inhibits the induction of spreading depolarizations.

Since the memories of two experiences are coallocated to overlapping engram cells, these two memories become linked (or integrated); thinking of one experience automatically makes one think of the second. A continuum of engram accessibility states may exist. Engrams may be entirely unavailable and not retrievable, even through artificial means (the memory would be forgotten). Or, engrams may be silenced such that memories may be retrieved by artificially reactivating engram cells. Consolidation depends on retrieval to occur if neural activity patterns in the hippocampus correspond to those that occurred during a previous experience are reactivated. Retrieval occurr specifically in REM-phases of sleep, where dreaming is dominant and memories from various, seemingly random (engram) sources are surfacing unconsciously. Retrieval of a single stimulus-response association can drive behavior directly or, confronted with multiple options, the brain may recall specific episodes of past experience for decision-making or planning, giving rise to new ideas. Retrieval may support imagination or intuition, which can be understood as the rearrangement or elaboration of stored information in the mental simulation of future possibilities

Epigenetic mechanisms of gene regulation are critically involved in processes underlying learning and memory. Epigenetic control of gene expression begins with a relaxation of compact chromatin at sites of the genes to be activated. Events, that are dependent on posttranslational modifications of histone proteins and cytidine methylations or hydroxymethylations of DNA, all of which are digital events. Neuronal activity can influence gene expression by dynamic DNA methylation. In excitatory neurons of cerebral cortex, DNA methyltransferases (DNMTs) have been shown to modulate synaptic transmission, synaptic scaling and neuronal excitability. De regulated expression of DNMT is associated to defects in the GABA ergic system in patients with neuropsychiaytric diseases like schizophrenia which strongly suggests important influences of DNMTs on inhibitory interneurons as well.In the brain, there is an epigenetic switchboard of incomprehensibly large yes/no options that are adjusted in response to environmental impact and demands, and induce optimized adaptations during subsequent, additional digital events. These mechanisms keep advancing in complex, non-linear ways determined by self-sustained switchboard reprofiling maintained during the whole life span of an organism. Although there is no way back, there are innumerable possibilities to correct existing and stored information and to endeavor new possibilities. The unique, unidirectional flow of information transfer represents the shift from digital to analogous encoding of information. There is a transition between the fundamentally one-dimensional (digital) information contained in nucleic acids to the three dimensional analog form of information embodied in proteins. Thsi flow of information is unique to teh barin and to biological systems in general.

All-or-nothing modifications do not provoke yes-or-no transcription, but solicit graded transcription dependent on the combination and overall sum of all modifications allowing for successful assembly of the initiation complex. This may result in linear or more sigmoidal time courses of gene expression and outcomes are analog events. Protoplasmic astrocytes are instrumental in learning and behavior even more than neurons. They are not only necessary but sufficient for new memory formation. The intimate embracement of synapses by thin astrocytic processes coined the tripartite synapse postulates that teh synapse can no longer be considered as only engaging two neuronal elements isolated from the rest of the parenchyma. Not all synapses are in immediate contact with perisyanptic astrocytic processes. (PAPs). They may engage and disengage from synapses spontaneously or in response to physiological (and pathological) stimuli. During LTP induction, more PAPs become associated to activated synapses supported by RNA translation within PAPs. In neocortex, 30–60% of synapses are enwrapped by astrocytes 60–90% in hippocampus and up to 90% in the somatosensory cortex layer IV.

Numerous synaptic contacts assign an intriguing role to astrocytic processes in spreading signal information to groups of neighboring synapses, an involvement in heterosynaptic plasticity that extends to a number of dendrites even if they do not belong to the same neuron (so-called heteroneuronal plasticity), which regulates switching between synaptic ensembles during information processing. An individual astrocyte interferes with the function of all(or subsets of) synapses within its domain.Synapses are functionally divided in two contiguous segments governed independently from one another if a dendrite passes through the domains of two distinct astrocytes. This concept embodies an extra layer of complexity in brain computation. Apart from the neuronal layout, polarity and connectivity, a mosaic of independent (though likely cooperating) astrocyte domains add additional control mechanisms to separate volumes of neuropil. Astrocytes affect spine maturation and the function of mature synapses in a “synaptic island”-restricted manner. Large neuronal dendrites may cross domains of hundreds of different astrocytes, which results in reprogramming various synaptic inputs by independent astroglial cells. Dendritic synaptic inputs not only are shaped by signals from multiple, incoming, pre-synaptic neurons, but also activities of multiple astrocytes embedding the dendritic network.Ribonucleic acid expression is enhanced in neurons during excitation, and declines sharply afterward. After neuronal excitation, sustained increased RNA production has been observed in astrocytes, which coincides with the period of trace retention. Astrocytes are not electrically excitable, but they are well-known for both stimulus-induced and spontaneous intracellular calcium signals that do not propagate to neighboring astrocytes through gap junctions. The majority are observed in peripheral thin processes rather than in their soma and do not result from mobilization of internal calcium stores

Communication between astroglia and neurons has profound impact on synaptic transmission. Astroglia contain neuronal excitability, release probability and insertion of postsynaptic AMPA receptors, which results in synapse silencing. This strongly impacts on the threshold balance between long-term potentiation and long-term depression. Synaptic transmission can be significantly modified by specific proteins produced in astrocytic fibers such as glutamate transporters (GLT1) glutamine synthetase, aquaporins, potassium channels, cell adhesion molecules (ephrin)), and lactate transporters. Astrocytic release of (glio-) transmitters directly interacts with pre- or post-synaptic neuronal receptors stream-lining synaptic efficacy, potency or plasticity. Glutamate released by astrocytes into the synaptic cleft modifies axonal conduction, broadens action potentials and can transiently enhance presynaptic cell transmitter release.

Astrocytes may co-express virtually as many as six different neurotransmitter and neuromodulator receptors (glutamate, dopamine, norepinephrine, acetylcholine, serotonin, and GABA). But their expression may be region-specific for instance, dopamine receptors are found in astrocytes of the substantia nigra and in prefrontal cortex whereas glutamate receptors are encountered throughout gray matter witnessing the wide-spread release of glutamate by excitatory synapses everywhere in the CNS. Due to this occurrence, this transmitter is the best candidate to be involved in consciousness and memory formation provided that consciousness and memory are disseminated all over the brain. Moreover, adrenergic receptors are more abundant in astrocytes than in neurons.Astrocyte microdomains, which are quasicrystalline gap junctional plaques, approximately 1.5–12 um in diameter, are considered as the basic structures of postsynaptic information processing. They are assembled into packages of memories in a crystalline array by crystallization into a long-lived highly resistant state and may be activated during conscioussness. Astrocytes express heterotypic gap junctions that specifically connect to and communicate with all other macroglia and vascular elements forming a functional “panglial syncytium”. “glial cells of this integrative system of global glial communication network coordinate all types of information in the brain”. It has been shown that siRNA can use gap junctions to travel from one cell to another and modify gene expression in the recipient cell. In this way, the astroglial syncytium is fundamental for the formation of long-term memories by epigenetic regulation of DNA throughout the brain.

This syncytium centrally located between individual synapses and global neuronal networks is viewed as a complex heterogeneous system that is multifunctional and closely regulated the primary coordinator of brain information processing, including consciousness memories intentionality, and development of motor responses. The glial network has been proposed as the “true substrate for information processing”–“where the thoughts dwell” synonymous with the “mind,” and the manifestation of the “global workspace”. Such a critical position suggests that this massive structure of interconnected astrocyte domains forms the body of the computational power of the brain.Adverse effect on the computational tasks of astrocytes significantly interferes with neuronal computation. Neurons distinguish incoming stimuli within a few milliseconds as individual entities, whereas astrocyte Ca2 + transients, the tentative astrocytic substrates of neural computing, are too slow to encode ultrafast representations. This property serves as a complementary manner to cover various time scales. Computationally, attention consists of a gain change (in amplitude of response or contrast) that results in the prioritization of relevant inputs over irrelevant information. Astrocytes assist to identify signal coincidence and help prioritize information by regulation of gain. Variations of Ca2 + -dependent glutamate uptake may impede or enhance excitatory synaptic drive or excitatory and inhibitory neurotransmission. Regulation of gain may also encompass gliotransmission and intrinsic neuronal excitability. Regulation of excitatory synaptic strength through gain control can be achieved by lowering glutamate uptake. The involvement of astrocytes in cortical slow oscillations (<1 Hz) underlines the involvement of astrocytes in network activity beyond tripartite synapses. Slow oscillations are believed to be the default mode of cortical network activity. Neurons transmit instructions to astrocytes to make other neurons modify their activity via canonical computations.

Neurons may imprint external signals like odors, position, images, words, abstract categories, and executive functions on networks, but astrocytes enable them to design and to operate canonical computations in local mini-circuits within larger-scale networks. Those canonical computations are manifestations of computation of error-related statistics and/or time in different contexts. Astrocyte-mediated filtering of synaptic transmission (denoted as “astrocyte-like control”) involves formation of so-called logic gates. Neuron-focused studies should be viewed as computational elements within astrocyte mini-circuits, because dendrites and spines are embedded in an astrocyte “matrix”. Since astrocytes participate in neuromodulation they encode precision by temporally compensate prediction errors resulting from multiple synapses in astrocyte mini-circuits, to warrant sufficient statistics. The variable “precision” or “standard error” may be improved within a range of seconds by neuromodulators. Those molecules produce slower and more diffuse effects than transmitters, which eventually results in generation of brain states. State-dependent excitability of neuronal networks is associated with specific cognitive functions.

During induction of synaptic plasticity, slow temporal properties of astrocytes are essential to maintain the history of past activity. Computational models predict, that astrocytes improve synchronization of firing, and synaptic coordination. Networks are tuned to oscillatory rhythms underlying memory processing and integration of astrocytes improves network performance. Within the syncytium, astrocytes may coordinate the excitability of functional neuronal ensembles and support their energetic demands. Even at relatively high levels of precision in the cell, analog computation is more efficient in its use of resources than deterministic digital computation.Nerve cells communicate with each other through two mechanisms, referred to as fast and slow synaptic transmission. Fast acting neurotransmitters e.g. gluatamate (excitatory) and gamma-aminobutyric acid (GABA) (inhibitory) achieve effects on their target cells within on emillisecond by virtue of opening ligand –operated ion channels. All of the effects of the biogenic amine and peptide neurotransmitters as well as many of the effects of glutamate and GABA , are achieved over hundreds of milliseconds to minutes by slow synaptic transmission mediated through an anormously more complicated sequence of biochemical steps involving second messengers , protein kinases and phosphateases. Slow acting neurotransmitters control the efficacy of fast synaptic transmission by regulating the effivciency with which fast-acting neurotransmitters produce their effects on postsynaptic receptors.

Advances in computing technology have made processing large-scale data feasible. Quantum computing (QC) has shown the potential in solving complex tasks much faster thanclassical computers. QC is underpinned by quantum mechanics, and explained through conceptsof superposition, interference, and entanglement. In quantum physics, a single bit can be in more than one state simultaneously (i.e., 1 and 0) at a given time, and a QC system leverages and recognizes asa qubit (Quantum bit). Having roots in quantum physics, QC has the potential of becoming the fabric of tomorrow’s highly powerful computing infrastructures, enabling the processing of giganticamounts of data in real time. QC is particularly well-suited to numerous compute-intensive applications of health care, especially in the current highly connected Internet of things (IoT) digital health care paradigm, which encompasses interconnected medical devices (such as medical sensors) that may be connected to the Internet or the cloud.The massive increase in computational capacity is not only beneficial for health care but can allow quantum computers to enable fundamental breakthroughs in this domain. Leaping from bits to qubits, can improve healthcare pharmaceutical research, which includes analyzing the folding of proteins, determining how molecular structures, for instance, drugs and enzymes, fit together, determining strengths of binding interactions between a single biomolecule, for example, protein or DNA, and its ligand/binding partner such as a drug or inhibitor, and accelerating the process of clinical trials. A quantum computer can perform extremely fast DNA sequencing, which opens the possibility. For personalized medicine and enables the development of new therapies and medicines through detailed modeling. Quantum computers have the potential to create efficient imaging systems that can provide clinicians with enhanced fine-grained clarity in real time and can solve complex optimization problems involved in devising an optimal radiation plan that is targeted at killing cancerous cells without damaging the surrounding healthy tissues. QC is set to enable the study of molecular interactions at the lowest possible level, paving the pathway to drug discovery and medical research. Whole-genome sequencing is a time-demanding task, but with the help of qubits, whole-genome sequencing and analytics can be implemented in a limited amount of time. QC can revolutionize the healthcare system through modern ways of enabling on-demand computing, redefining security for medical data, predicting chronic diseases, and accurate drug discoveries. Quantum computing, that provides an incremental speed up of disease diagnosis and treatment can drastically reduce the computation times from years to minutes. The domain of precision medicine focuses on providing prevention and treatment methodologies for individuals’ healthcare needs. Due to the complexity of the human biological system, personalized medicine will be required in the future that will go beyond standard medical treatments.

Healthcare workers may use tools to discover the impact of risks on individuals in given condition changes by continual virtual diagnosis based on continuous data streams. Drug sensitivity at a cellular level considering genomes features of cancer cells and discovering the chemical properties of drug models that could be used for predicting cancer efficiency at a granular level are the topics of ongoing research. Precision medicine has the goal of identifying and explaining relationships among causes and treatments and predicting the next course of action at an individual level. Traditional diagnosis based on the patient’s reported symptoms results in umbrella diagnoses, where the related treatments tend to sometimes fail. Quantum computing helps in utilizing continuous data streams using personalized interventions in predicting diseases and allowing relevant treatments. Quantum-enhanced predictive medicineoptimizes and personalizes healthcare services using continuous care. Patient adherence and engagement at individual-level treatments can be supported by quantum-enhanced modeling. Early diagnosis of the diseases can render better prognosis and treatment, as well as lower the healthcare cost. The current diagnostics and treatment for most of the diseases are costly and slow, having deviations in the diagnosis of around 15–20% . The use of X-rays, CT scans, and MRIs has become at a faster pace with computer- aided diagnostics developing. In this situation, diagnoses and treatment would not suffer from noise, data quality, and replicability issues. In this regard, quantum-assisted diagnosis has the potential to analyze medical images and oversee the processing steps, such as edge detection in medical images, which improves the image-aided diagnosis.

The current techniques use single-cell methods for diagnosis, while analytical methods are needed in single-cell sequencing data and flow cytometry. These techniques require advanced data analytic methods, particularly combining datasets from different techniques. In this context, cell classification on the basis of biochemical and physical attributes is regarded as one of the main challenges. While this classification is vital for critical diagnoses, such as cancerous cell integration from healthy cells, it requires an extended feature space where the predictor variable becomes considerably larger. Quantum techniques, such as quantum vector machines (QVM), enable single-cell diagnostic methods. The discovery and characterization of biomarkers pave the way for the study of intricate omics datasets, such as metabolomics, transcrip tomics, proteomics, and genomics. These processes lead to increased feature space, provoking complex patterns and correlations that are nearly impossible to be analyzed using classical computational methodologies. During the diagnosis process, quantum computing may help to support the diagnostics insights, eliminating the need for repetitive diagnosis and treatment at the same time. This paradigm helps in providing continuous monitoring and analysis of individuals’ health in performing meta-analysis for cell-level diagnosis to determine the best possible procedure at a specific time and to reduce the cost and allow extended data-driven diagnosis, bringing value for both medical practitioners and individuals.

Radiation therapy a sensitive process, that has been employed for the treatment of cancers using radiation beams to eliminate cancerous cells to stop them from multiplying requires highly precise computations to drop the beam on the cancer-causing tissues and avoid any impact on the surrounding healthy body cells. Radiography, requires to be performed using highly precise computers with multiple and complex simulations to reach an optimal solution. Through quantum computing, and by running simultaneous simulations, figuring out a plan in an optimal time becomes possible, with very vast spectrum of opportunities if quantum concepts are employed for simulations. Quantum computing enables medical practitioners to model atomic-level molecular interactions, which is necessary for medical research. This will be particularly essential for diagnosis, treatment, drug discovery, and analytics. Due to the advancements in quantum computing , it is now possible to encode tens of thousands of proteins and simulate their interactions with drugs, which has not been possible before .

Quantum computing processes this information more effectively by orders of magnitude as compared with conventional computing capabilities and allows doctors to simultaneously compare large collections of data and their permutations to identify the best patterns. Detection of biomarkers specific to a disease in the blood is now possible through gold nanoparticles by using known methods, such as bio-barcode assay. The goal should be to exploit the comparisons used to help the identification of a diagnosis. Identifying small molecules, macromolecules, and other molecular formations that develop into drugs that treat or cure diseases is a core activity of pharmaceutical companies. Many important drugs have been discovered in the past by way of scientific fortuity, with some notable examples being penicillin, chloral hydrate, LSD, and the smallpox vaccine. To tackle modern-day challenges such as those related to climate change and the COVID-19 virus, chemists cannot rely on luck alone. Modern-day drug discovery requires precise modeling of the energies dissipated in chemical reactions. Classical computers rely heavily on approximations, because even just calculating the quantum behavior of a couple of electrons involves very time- consuming computation. Quantum computers are already reliably modeling the properties of small molecules, such as lithium hydride, to benefit quantum chemistry calculations requiring an explicit depiction of the wave function of high system entanglement, because they simulate properties at high accuracies and reduce the precision and value of the model and guide and validate the result in the lab.Researchers have developed several quantum algorithms for chemistry, to estimate the ground-state energies and compute molecular reaction rates that are superior to their classical computing counterparts. It is even possible to accurately compute circuitry exhibiting noise with quantum chemistry. Creating pricing strategies is considered one of the key challenges that contribute to the complexities of the healthcare ecosystem. In pricing analysis, quantum computing helps in risk analysis by predicting the current health of patients and predicting whether the patient is prone to a particular disease. This is useful for optimizing insurance premiums and pricing.

A population-level analysis of disease risks, and mapping that to the quantum-based risk models, could help in computing financial risks and pricing models at a finer level. One of the key areas which could support pricing decisions is the detection of fraud; healthcare frauds cost billions of dollars in revenue. In this regard, traditional data mining techniques offer insights into detecting and reducing healthcare fraud. Quantum computing can provide higher classification and pattern detection performance, uncovering malicious behavior attempting fraudulent medical claims. This could in turn help in better management of pricing models and lowering the costs associated with frauds. Quantum computing can substantially accelerate pricing computations resullting not only lowering the premiums but also in developing customized plans. Different tests and systems, based on historical data, MRIs, CT scans, etc., can become one of the quantum computing applications. Quantum computing can help in performing DNA sequencing, which takes 2–3 months using classical computing and perform cardiomyopathy analysis for DNA variants promptly. Although the growth of quantum computing brings novel benefits to healthcare, the broad use of novel quantum techniques may provoke security challenges. Therefore, there is a need to invest in quantum computing for better healthcare services provisioning. Vaccine research can be automated more efficiently.

There is a need to allocate distributed quantum computing, where a quantum supercomputer could distribute its resources using the cloud. Requirements of Quantum Computing for Healthcare Quantum-enhanced computing can decrease processing time in various healthcare applications. Drug discovery requirements are different from vaccination development systems. Quantum computing applications in healthcare require consideration of multiple factors for effective implementation. Solving certain complex healthcare problems, e.g., simulating molecular structures motivates the need for using quantum computing that can exploit vast amounts of multidimensional spaces to represent large problems and demonstrates remarkable efficiency in computational power. High- Speed (5G/6G Networks) and fifth-generation (5G) connectivity has become an essential technology connecting as well as smart medical objects and provides extremely robust integrity, lower latency, higher band width, with an extremely large capacity by transferring data to edge/cloud infrastructure for processing. Cloud storage suffers from security issues from a user perspective, thus raising novel challenges associated with the availability, integrity, and confidentiality of data.

Quantum computing can gain benefits from 5G/6G networks to provide novel services. Quantum walks, that are the mechanical counterparts of traditional random walks that allow to develop novel quantum algorithms and protocols using high-speed 5G/6G networks, deliver a universal processing model and inherent cryptographic features as efficient solutions for the healthcare paradigm. It has been verified that even simple neural networks, can precisely imitate the state of many-body quantum systems. Research on brain oscillations has brought up a picture of coupled oscillators. It is argued that physiologically, two basic coupling principles govern brain as well as body oscillations:

(i) amplitude (envelope) modulation between any frequencies m and n, where the phase of the

slower frequency m modulates the envelope of the faster frequency n, and

(ii) phase coupling between m and n, where the frequency of n is a harmonic multiple of m.

An analysis of the center frequency of traditional frequency bands and their coupling principles

suggest a binary hierarchy of frequencies leading to the foundation of the binary hierarchy brain

body oscillation theory. (573-620)

**Conclusion**

Evidence emerging within the past several decades suggests that psychosocial factors from emotional states, such as depression, behavioral dispositions, such as hostility, and psychosocial stress directly influence both physiologic function and health outcomes.Mind-body therapies (MBTs)(eg, relaxation, stress management, meditation, biofeedback) can be effective adjunctive treatments for an array of health-relatedproblems,in the areas of chronic low backpain,headache disorders,insomnia,cardiac rehabilitation (prevention of postinfarction morbidity/mortality),management of treatment and disease-related symptoms in cancer,osteoarthritis,rheumatoid arthritis,and postsurgicaloutcomes,and the treatment of hypertension. It has been argued that medicine must shift from an exclusively “biomedical” model to a “biopsychosocial” understanding of health and illness. Paradigms, determined by cultural differences and perceptions of reality, define the borderline between science and pseudoscience.

Mind–body therapies that empower the patient and promote patient-centered care have been associated with improved patient satisfaction, better health outcomes and state of health, as well as reduced utilization of health care services. The implementation of effectıve and safe mind–body therapies as an essential part of a practical, holistic, integrative approach , give potential benefits (e.g., promotion of self-efficacy, relative low cost,ability to be self-directed, decreaseduse of other clinical support systems, improvement infunction, return to work, quality of life, and decrements in use of opioids and polypharmacy approaches to care). Basic sciences and clinical data have fostered the evidence-based integration of MBTs into clinical care , integration into clinical practice of MBTs and other Integrative Medicine modalities holds significant promise for reducing the burden of chronic diseases and lowering the overall cost of healthcare. A mind getting aware of the reality, can command over his body. This does not mean to cope with or ignore it by distracting but by truly knowing. Actually, there is no duality of mind and body or spirit. The human being explains the diseases by separating the somatic body and psyche.In ancient traditions, the individual was taken as a psychological being. The modern medicine has divided the body and the mind, but recently a trend toward personalized and holistic approach especially in traditional and complementary medicine integration considering the human being a bio- psychological-social and spiritual being, has been emphasized.

Quantum theory which has replaced mechanistic theory, forces to revise the current medical approach in favor of human being and reconceptualize the patient-doctor communication, diseases and therapeutic modalities, reconsidering the patient as a wholebeing, visualising the environment with relatives, parents, families, friends, neighbors etc. and the mind’s power.If the body has not been existed, the brain would have not existed. Without the existence of the brain,the mind would not have existed. Finally, there are no two different identities. The brain-a part of the body , but is also the control center at the same time. It is not just a somatic anatomical body but also an electromagnetic field which surrounds in a colorful aura. Getting through informational channels , it is possible to detect and treat the disturbances at energy level in vibrational medicine. The disturbances can be found at early stage and cured without pharmacological or invasive interventions; complications,and side effects, unlike by the current methods. Instead of cure, the patients are presently labelled with a disease and become life time dependent on medicines, and need more drugs to suppress the side effects. Just a confidential and trustful communication can be the main method to help and heal the patient ,instead of replacing the patient as a virtual identity with a set of symptoms and signs supported by biochemical or microbiological analyses and radiologic images or electrical measurements.

REFERENCES

1. L. Vıtetta, B. Anton, F. Cortızo, and A. Salı . (2005)Mind–Body Medicine . Stress and Its Impact on Overall . Health and Longevity. Ann. N.Y. Acad. Sci. 1057: 492–505 (2005). © New York Academy of Sciences. doi: 10.1196/annals.1322.038
2. Robinson, Howard, (2023) "Dualism", The Stanford Encyclopedia of Philosophy (Spring 2023 Edition), Edward N. Zalta & Uri Nodelman (eds.), URL = <https://plato.stanford.edu/archives/spr2023/entries/dualism/>.
3. Tanney, Julia, "Gilbert Ryle", (2022). The Stanford Encyclopedia of Philosophy (Summer 2022 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2022/entries/ryle.
4. Shanjendu Nath Ryle. (2013) as a critique of Descartes’ Mind-Body Dualism .International Journal of Scientific and Research Publications, Volume 3, Issue 7, July 2013 1 ISSN 2250-3153 www.ijsrp.org
5. Odegard, D. (1970). Locke and Mind-Body Dualism. *Philosophy*, *45*(172), 87–105. <http://www.jstor.org/stable/3749796>
6. Manning R. (2024).Spinoza’s Physical Theory, The Stanford Encyclopedia of Philosophy (Summer 2024 Edition). Edward N. Zalta &Uri Nodelman (eds). URL=<https://plato.stanford.edu/archives/sum2024/entries/spinoza-physics/>
7. Schein Noa. (2023). Spinoza’s Theory of Attributes. The Stanford Encyclopedia of Philosophy(Summer 2023 Edition). Edward. N. Zalta&Uri Nodelman (eds).URL=<https://plato.stanford.edu/archives/sum2023/entries/spinoza-attributes/>
8. Flage, D. E. (1982). Hume’s Dualism. *Noûs*, *16*(4), 527–541. <https://doi.org/10.2307/2215205>
9. Pitson, A. E. (2000). Hume and the Mind/Body Relation. *History of Philosophy Quarterly*, *17*(3), 277–295. http://www.jstor.org/stable/27744856
10. Hocutt, M. (2018). George Berkeley Resurrected: A Commentary on Baum’s “Ontology for Behavior Analysis.” *Behavior and Philosophy*, *46*, 47–57. <https://www.jstor.org/stable/26626603>
11. Campbell, N.. (2001). What Was Huxley's Epiphenomenalism?. Biology & Philosophy. 16. 357-375. 10.1023/A:1010670809779
12. Klein A. (2019). William James’s objection to epiphenomalism. Philosophy of Science. 2019;86(5):1179-1190.doi:10.1086/705477
13. Smart, Jjc (2007). The Mind/Brain Identity Theory. *Stanford Encyclopedia of Philosophy*.
14. Myin E, Zahnoun F. (2018).Reincarnating the Identity Theory. Front Psychol. 2018 Oct 24;9:2044. doi: 10.3389/fpsyg.2018.02044. PMID: 30405507; PMCID: PMC6207612.
15. Ahmed Ziad. (2025). Dualism – Gilbert Ryle's Critique of Cartesian Mind-Body Separation. *Asian Philosophy* 24.
16. Watson, J.B. (1998). Behaviorism (1st ed.). Routledge. <https://doi.org/10.4324/9781351314329>
17. Graham, George, (2023). "Behaviorism", The Stanford Encyclopedia of Philosophy (Spring 2023 Edition), Edward N. Zalta & Uri Nodelman (eds.), URL = <https://plato.stanford.edu/archives/spr2023/entries/behaviorism/>.
18. MalcolmN&Altuner I. (2014). Logical Behaviorism. Beytulhikme. An International Journal of Philosophy;4(2).77-93.https://doi.org/10.18491/bijop.25795
19. Richard F. Kitchener, (1999).14 - Logical behaviorism, Editor(s): William O'Donohue, Richard Kitchener,Handbook of Behaviorism,Academic Press,

1999,Pages 399-418,ISBN 9780125241908,https://doi.org/10.1016/B978-012524190-8/50015-2(https://www.sciencedirect.com/science/article/pii/B9780125241908500152)

1. Levin, Janet, (2023). "Functionalism", The Stanford Encyclopedia of Philosophy (Summer 2023 Edition), Edward N. Zalta & Uri Nodelman (eds.), URL = <https://plato.stanford.edu/archives/sum2023/entries/functionalism/>.
2. Loaiza J. R. (2024). Functionalism and the emotions. British Journal for the Philosophy of Science, 75(1), 1–34. https://doi.org/10.1086/715207
3. Shagir O. (2005). The rise and fall of computational functionalism. In: Ben-Menahem Y. Ed. Hilary Putnam. Contemporary Philosophy in Focus. Cambridge University Press, 2005:220-250
4. Gordon, Andrew & Hobbs, Jerry. (2011). A Commonsense Theory of Mind-Body Interaction.. AAAI Spring Symposium - Technical Report.
5. Gordon, A. S., & Hobbs, J. R. (2017). *A formal theory of commonsense psychology: How people think people think.* Cambridge University Press. [https://doi.org/10.1017/9781316584705](https://awspntest.apa.org/doi/10.1017/9781316584705)
6. Andrew S. Gordon and Jerry R. Hobbs. A Commonsense Theory of Mind-Body Interaction Association for the Advancement of Artificial Intelligence. ([www.aaai.org](http://www.aaai.org))
7. Adolphs R., Anderson D. J. (2018). The neuroscience of emotion: A new synthesis. Princeton University Press
8. Ye-Seul Lee, Yeonhee Ryu, Won-Mo Jung, Jungjoo Kim, Taehyung Lee, and Younbyoung Chae. (2017).Understanding Mind-Body Interaction from the Perspective of East Asian Medicine. Evidence-Based Complementary and Alternative Medicine. Volume 2017, Article ID 7618419, 6 pages
9. <http://speakingoffaith.publicradio.org/programs/stress/mindbodyessay.shtml>
10. Robert Ader. (2000).On the development of psychoneuroimmunology,European Journal of Pharmacology,Volume 405, Issues 1–3,2000,Pages 167-176,ISSN 0014-2999,https://doi.org/10.1016/S0014-2999(00)00550-1. (https://www.sciencedirect.com/science/article/pii/S0014299900005501)
11. Kelly KW.(2021).From Psychoneuroimmunology to immunopsychiatry. A Historical Perspective. In: Khnadaker G, Harrison N, Bullmore E, Dantzer R, eds Textbook of Immunopsychiatry. Cambridge University Press; 2021: 25-50.
12. Daruna, J.H.. (2012). Introduction to Psychoneuroimmunology. 10.1016/C2009-0-01965-5.
13. Mravec B, Tibenský M, Horváthová Ľ. (2018).Psychoneuroimmunology of Cancer - Recent Findings and Perspectives. Klin Onkol. 2018 Fall;31(5):345-352. English. doi: 10.14735/amko2018345. PMID: 30541320
14. Besedovsky HO, Rey AD. (2007). Physiology of psychoneuroimmunology: a personal view. Brain Behav Immun. 2007 Jan;21(1):34-44. doi: 10.1016/j.bbi.2006.09.008. PMID: 17157762.
15. Ott, M., Singer, M., Bliem, H. R., & Schubert, C. (2021). Prenatal psychoneuroimmunology. In K. Evertz, L. Janus, & R. Linder (Eds.), *Handbook of prenatal and perinatal psychology: Integrating research and practice* (pp. 115–147). Springer Nature Switzerland AG. [https://doi.org/10.1007/978-3-030-41716-1\_8](https://psycnet.apa.org/doi/10.1007/978-3-030-41716-1_8)
16. McLeod JD. (2012). The meaning of stress: expanding stress process model. Soc Ment Health(2012)2:172-186. Doi.:10.1177/2156869312452877.
17. Brückmann, R., Tuchscherer, M., Tuchscherer, A., Gimsa, U., & Kanitz, E. (2020). Early-Life Maternal Deprivation Predicts Stronger Sickness Behaviour and Reduced Immune Responses to Acute Endotoxaemia in a Pig Model. International Journal of Molecular Sciences, 21(15), 5212. https://doi.org/10.3390/ijms21155212
18. Funk, Leonhard. (2015). Dissertation: Investigation of Stress System under Real Life Conditions (2006). 10.13140/RG.2.1.1222.6725.
19. Verkerk, R. (2009). Can the failing western medical para digm be shifted using the principle of sustainability? Australasian College of Nutritional & Environmental Medicine, 28, 4–10.
20. Nishimura, Chiaki & Wang, Li-Qun & Nagase, Aki & Terada, Kazuko & Miyamoto, Yoshifumi & Tsukuma, Hisayuki & Muro, Masuo. (2007). A learning model of autonomic function in biofeedback. International Congress Series. 1301. 119-122. 10.1016/j.ics.2006.12.001.
21. Malik K, Dua A. Advancing Patient Care With Biofeedback. [Updated 2025 Jan 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK553075/>
22. Allen, K. D. (2007). EMG biofeedback treatment of dysphonias and related voice disorders.The Journal of Speech and Language Pathology – Applied Behavior Analysis, 2(2), 149–157. https://doi.org/10.1037/h0100213
23. Ramirez-Garcia, M.P., Leclerc-Loiselle, J., Genest, C. *et al.* (2020).Effectiveness of autogenic training on psychological well-being and quality of life in adults living with chronic physical health problems: a protocol for a systematic review of RCT. *Syst Rev* **9**, 74 (2020). <https://doi.org/10.1186/s13643-020-01336-3>
24. Sitaram, R., Ros, T., Stoeckel, L. *et al.* (2017)Closed-loop brain training: the science of neurofeedback. *Nat Rev Neurosci* **18**, 86–100 (2017). https://doi.org/10.1038/nrn.2016.164
25. Marzbani H, Marateb HR, Mansourian M. (2016).Neurofeedback: A Comprehensive Review on System Design, Methodology and Clinical Applications. Basic Clin Neurosci. 2016 Apr;7(2):143-58. doi: 10.15412/J.BCN.03070208. PMID: 27303609; PMCID: PMC4892319.
26. Lehrer, P. (2022) My Life in HRV Biofeedback Research. *Appl Psychophysiol Biofeedback* 47, 289–298 (2022). https://doi.org/10.1007/s10484-022-09535-5
27. Lehrer, P. M. (2021). Biofeedback training to increase heart rate variability. In P. M. Lehrer & R. L. Woolfolk (Eds.), Principles and practice of stress management (4th ed., pp. 264–302). The Guilford Press.
28. Capdevila, L., Parrado, E., Ramos-Castro, J. *et al.* (2021).Resonance frequency is not always stable over time and could be related to the inter-beat interval. *Sci Rep* 11, 8400 (2021). https://doi.org/10.1038/s41598-021-87867-8
29. Shaffer F, Ginsberg JP. (2017). An Overview of Heart Rate Variability Metrics and Norms. Front Public Health. 2017 Sep 28;5:258. doi: 10.3389/fpubh.2017.00258. PMID: 29034226; PMCID: PMC5624990.
30. Soer, R., Dijkstra, M. W. M. C. S., Bieleman, H. J., Oosterveld, F. G. J., & Rijken, N. H. M. (2021). Influence of respiration frequency on heart rate variability parameters: A randomized cross-sectional study. Journal of Back and Musculoskeletal Rehabilitation, 34(6), 1063-1068. https://doi.org/10.3233/BMR-200190
31. Homma I, Masaoka Y. (2008).Breathing rhythms and emotions. Exp Physiol. 2008 Sep;93(9):1011-21. doi: 10.1113/expphysiol.2008.042424. Epub 2008 May 16. PMID: 18487316.
32. Masaoka Y, Izumizaki M, Homma I. Where is the rhythm generator for emotional breathing? Prog Brain Res. 2014;209:367-77. doi: 10.1016/B978-0-444-63274-6.00019-9. PMID: 24746058.
33. Takeshi Kuroda, Yuri Masaoka, Hideyo Kasai, Kengo Noguchi, Mitsuru Kawamura, Ikuo Homma. (2012). Sharing breathlessness: Investigating respiratory change during observation of breath-holding in another,Respiratory Physiology & Neurobiology,Volume 180, Issues 2–3,2012,Pages 218-222,ISSN 1569-9048, https://doi.org/10.1016/j.resp.2011.11.010.
34. Yoshitaka Oku (2022).Temporal variations in the pattern of breathing: techniques, sources, and applications to translational sciences,The Journal of Physiological Sciences,Volume 72, Issue 1,2022,22,ISSN 1880-6546,https://doi.org/10.1186/s12576-022-00847-z.
35. Malthe Brændholt, Daniel S. Kluger, Somogy Varga, Detlef H. Heck, Joachim Gross, Micah G. Allen. (2023). ,Breathing in waves: Understanding respiratory-brain coupling as a gradient of predictive oscillations,Neuroscience & Biobehavioral Reviews,Volume 152, 2023,105262,ISSN 0149-7634, https://doi.org/10.1016/j.neubiorev.2023.105262.
36. Chaitanya S, Datta A, Bhandari B, Sharma VK.(2022). Effect of Resonance Breathing on Heart Rate Variability and Cognitive Functions in Young Adults: A Randomised Controlled Study. Cureus. 2022 Feb 13;14(2):e22187. doi: 10.7759/cureus.22187. PMID: 35308668; PMCID: PMC8924557.
37. S. Laborde, M.S. Allen, U. Borges, F. Dosseville, T.J. Hosang, M. Iskra, E. Mosley, C. Salvotti, L. Spolverato, N. Zammit, F. Javelle. (2022). ,Effects of voluntary slow breathing on heart rate and heart rate variability: A systematic review and a meta-analysis,Neuroscience & Biobehavioral Reviews,Volume 138,2022,104711,ISSN 0149-7634,https://doi.org/10.1016/j.neubiorev.2022.104711.(https://www.sciencedirect.com/science/article/pii/S0149763422002007)
38. Lehrer PM, Vaschillo EG, Vidali V. (2020).Heart Rate and Breathing Are Not Always in Phase During Resonance Frequency Breathing. Appl Psychophysiol Biofeedback. 2020 Sep;45(3):145-152. doi: 10.1007/s10484-020-09459-y. PMID: 32285231.
39. Kulbhushan Chand, Shilpa Chandra, Varun Dutt,A comprehensive evaluation of linear and non-linear HRV parameters between paced breathing and stressful mental state,Heliyon,Volume 10, Issue 11,2024,e32195,ISSN 2405-8440,https://doi.org/10.1016/j.heliyon.2024.e32195.(https://www.sciencedirect.com/science/article/pii/S2405844024082264)
40. Bielecki JE, Tadi P. [Updated 2023 Jul 3]. Therapeutic Exercise. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK555914/
41. Jamil A, Gutlapalli SD, Ali M, Oble MJP, Sonia SN, George S, Shahi SR, Ali Z, Abaza A, Mohammed L. (2023). Meditation and Its Mental and Physical Health Benefits in 2023. Cureus. 2023 Jun 19;15(6):e40650. doi: 10.7759/cureus.40650. PMID: 37476142; PMCID: PMC10355843.
42. Michaela C. Pascoe, Michael de Manincor, Jana Tseberja, Mats Hallgren, Peter A. Baldwin, Alexandra G. Parker. (2021).Psychobiological mechanisms underlying the mood benefits of meditation: A narrative review. Comprehensive Psychoneuroendocrinology,Volume 6,2021,100037,ISSN 2666-4976,https://doi.org/10.1016/j.cpnec.2021.100037.
43. Tseng AA. (2022). Scientific Evidence of Health Benefits by Practicing Mantra Meditation: Narrative Review. Int J Yoga. 2022 May-Aug;15(2):89-95. doi: 10.4103/ijoy.ijoy\_53\_22. Epub 2022 Sep 5. PMID: 36329765; PMCID: PMC9623891.
44. Academic Mindfulness Interest Group M. (2006). Mindfulness-Based Psychotherapies: A Review of Conceptual Foundations, Empirical Evidence and Practical Considerations. *Australian & New Zealand Journal of Psychiatry*. 2006;40(4):285-294. doi:[10.1080/j.1440-1614.2006.01794.x](https://doi.org/10.1080/j.1440-1614.2006.01794.x)
45. Jahnke R, Larkey L, Rogers C, Etnier J, Lin F. A comprehensive review of health benefits of qigong and tai chi. Am J Health Promot. 2010 Jul-Aug;24(6):e1-e25. doi: 10.4278/ajhp.081013-LIT-248. PMID: 20594090; PMCID: PMC3085832.
46. Wu, M. T. et al. (2018).Task-switching performance improvements afer Tai Chi Chuan training are associated with greater prefrontal activation in older adults. Front. Aging Neurosci. 10, 280 (2018).
47. Liu, Z. et al. (1993).Reduced feelings of regret and enhanced fronto-striatal connectivity in elders with long-term Tai Chi experience. Soc. Cognit. Afect. Neurosci. 15(8), 861–873 (2020)
48. Aurobindo, S. (1993). Integral yoga: Sri Aurobindo’s teaching and method of practice. Twin Lakes, WI: Lotus Press.
49. Kaur, H. et al. (2022).Comparing cognition, coping skills and vedic personality of individuals practicing yoga, physical exercise or sedentary lifestyle: A cross-sectional fMRI study. Integr. Med. Res. 11(1), 100750
50. Chand SP, Kuckel DP, Huecker MR. [Updated 2023 May 23]. Cognitive Behavior Therapy. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470241/
51. Stefan Koelsch. (2009). A Neuroscientific Perspective on Music Therapy The Neurosciences and Music III—Disorders and Plasticity: Ann. N.Y. Acad. Sci. 1169: 374–384 (2009). doi: 10.1111/j.1749-6632.2009.04592.x c 2009 New York Academy of Sciences.
52. Thomas Hıllecke, Anne Nıckel, And Hans Volker Bolay. (2005). Scientific Perspectives on Music Therapy Ann. N.Y. Acad. Sci. 1060: 1–12 (2005). © 2005 New York Academy of Sciences. doi: 10.1196/annals.1360.020
53. American Music Therapy Association. (2012). What is music therapy? Retrieved from www.musictherapy.org/ about/musictherapy/
54. Williamson A.(2019). What is hypnosis and how might it work? Palliat Care. 2019 Jan 31;12:1178224219826581. doi: 10.1177/1178224219826581. PMID: 30728719; PMCID: PMC6357291.
55. Bitonte RA, De Santo M. (2014).Art Therapy: An Underutilized, yet Effective Tool. Ment Illn. 2014 Jul 3;6(1):5354. doi: 10.4081/mi.2014.5354. PMID: 25478139; PMCID: PMC4253394.
56. Norelli SK, Long A, Krepps JM. [Updated 2023 Aug 28] Relaxation Techniques.. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK513238/
57. Deng, G. E., Frenkel, M., Cohen, L., Cassileth, B., Abrams, D., Capodice, J.,…Sagar, S. (2009). Evidence-based clinical practice guidelines for integrative oncology: Comple mentary therapies and botanicals. Journal of the So ciety for Integrative Oncology, 7, 85–120. http://dx.doi. org/10.2310/7200.2009.0019
58. Cooksley, V. (2011). History of aromatics. In V. Cooksley & L. Pounds (Eds.), The Institute of Integrative Aromatherapy certificate training manual (p. 43). The Woodlands, TX: The Institute of Integrative Aromatherapy.
59. Falzon CC, Balabanova A. Phytotherapy: An Introduction to Herbal Medicine. Prim Care. 2017 Jun;44(2):217-227. doi: 10.1016/j.pop.2017.02.001. PMID: 28501226.
60. Patwardhan B. Bridging Ayurveda with evidence-based scientific approaches in medicine. EPMA J. 2014 Nov 1;5(1):19. doi: 10.1186/1878-5085-5-19. PMID: 25395997; PMCID: PMC423050
61. El Dhaybi,M. (2021). Traditional Chinese Medicine: The effect on the human therapy. International Journal of traditional Chinese Medicine Research.02(02)110-114. https://doi.org/10.53811/ijtcmr.940822.
62. Danning Ma, Shanshan Wang, Yu Shi, Shenglou Ni, Minke Tang, Anlong Xu. (2021).The development of traditional Chinese medicine,Journal of Traditional Chinese Medical Sciences,Volume 8, Supplement 1,2021,Pages S1-S9,ISSN 2095-7548, https://doi.org/10.1016/j.jtcms.2021.11.002
63. Matos LC, Machado JP, Monteiro FJ, Greten HJ. (2021).Understanding Traditional Chinese Medicine Therapeutics: An Overview of the Basics and Clinical Applications. Healthcare (Basel). 2021 Mar 1;9(3):257. doi: 10.3390/healthcare9030257. PMID: 33804485; PMCID: PMC8000828.
64. Merrell WC, Shalts E. (2002).Homeopathy. Med Clin North Am. 2002 Jan;86(1):47-62. doi: 10.1016/s0025-7125(03)00071-3. PMID: 11795090.
65. Ahmad husaın, G.D, Sofı Tajuddın, Raman Dang , Nılesh Kumar. (2010).Unanı system of medıcıne. Introductıon and challenges. Medical Journal of Islamic World Academy of Sciences 18:1, 27-30, 2010
66. Rahman SZ, Khan RA, Latif A. (2008). Importance of pharmacovigilance in Unani system of medicine. Indian J Pharmacol. 2008 Feb;40(Suppl 1):S17-20. PMID: 21369407; PMCID: PMC3038517.
67. Albert JP, Crubézy E. (2005).Medecine chamanique et modernite medicale [Shamanic healing in the age of modern medicine]. Med Trop (Mars). 2005;65(1):93-9. French. PMID: 15903086.
68. Elendu C.(2024). The evolution of ancient healing practices: From shamanism to Hippocratic medicine: A review. Medicine (Baltimore). 2024 Jul 12;103(28):e39005. doi: 10.1097/MD.0000000000039005. PMID: 38996102; PMCID: PMC11245246.
69. Teall, Emily K. (2014) "Medicine and Doctoring in Ancient Mesopotamia," Grand Valley Hajar R. The medicine of old India. Heart Views. 2013 Apr;14(2):92. doi: 10.4103/1995-705X.115497. PMID: 23983917; PMCID: PMC3752885.
70. Yogini S. Jaiswal, Leonard L. Williams. (2017).,A glimpse of Ayurveda – The forgotten history and principles of Indian traditional medicine,Journal of Traditional and Complementary Medicine,Volume 7, Issue 1,2017,Pages 50-53,ISSN 2225-4110,https://doi.org/10.1016/j.jtcme.2016.02.002.(<https://www.sciencedirect.com/science/article/pii/S2225411016000250>)
71. Vedam R, Pansare TA, Narula J. (2021).Contributions of ancient Indian knowledge to modern medicine and cardiology. Indian Heart J. 2021 Sep-Oct;73(5):531-534. doi: 10.1016/j.ihj.2021.09.010. Epub 2021 Sep 16. PMID: 34627563; PMCID: PMC8514395.
72. [Ankita Raikwar](https://www.qeios.com/profile/34966). (2023). [The Ancient Indian Knowledge System and the Medical Sciences.](https://doi.org/10.32388/8D3ZSX) Qeios. doi:10.32388/8D3ZSX.Journal of History: Vol. 3: Iss. 1 Article 2. Available at: https://scholarworks.gvsu.edu/gvjh/vol3/iss1/2
73. Retief FP, Cilliers L. (2021).Mesopotamian medicine. S Afr Med J. 2007 Jan;97(1):27-30. PMID: 17378276.
74. Dafni A&Boeck B. (2020). Revisiting the medicinal plants of the bible and the holy land. Research Outreach 114:122-5.https://researchoutreach.org/articles/revisiting-medicinal- plants-bible-holy-land/
75. Metwaly AM, Ghoneim MM, Eissa IH, Elsehemy IA, Mostafa AE, Hegazy MM, Afifi WM, Dou D.(2021). Traditional ancient Egyptian medicine: A review. Saudi J Biol Sci. 2021 Oct;28(10):5823-5832. doi: 10.1016/j.sjbs.2021.06.044. Epub 2021 Jun 19. PMID: 34588897; PMCID: PMC8459052.
76. Ahmed M. Metwaly, Mohammed M. Ghoneim, Ibrahim.H. Eissa, Islam A. Elsehemy, Ahmad E. Mostafa, Mostafa M. Hegazy, Wael M. Afifi, Deqiang Dou. (2021).Traditional ancient Egyptian medicine: A review,Saudi Journal of Biological Sciences.Volume 28, Issue 10,2021,Pages 5823-5832,ISSN 1319-562X,https://doi.org/10.1016/j.sjbs.2021.06.044.
77. Kleisiaris CF, Sfakianakis C, Papathanasiou IV. (2014).Health care practices in ancient Greece: The Hippocratic ideal. J Med Ethics Hist Med. 2014 Mar 15;7:6. PMID: 25512827; PMCID: PMC4263393.
78. Turner, N. (2019). Indigenous Peoples' Medicine in Canada. In *The Canadian Encyclopedia*. Retrieved from https://www.thecanadianencyclopedia.ca/en/article/native-medicines
79. Koithan M, Farrell C.(2010). Indigenous Native American Healing Traditions. J Nurse Pract. 2010 Jun 1;6(6):477-478. doi: 10.1016/j.nurpra.2010.03.016. PMID: 20689671; PMCID: PMC2913884.
80. Garcia-Kutzbach A. (1976).Medicine among the ancient Maya. South Med J. 1976 Jul;69(7):938-40. doi: 10.1097/00007611-197607000-00045. PMID: 781854
81. Rodrigo Castañeda, Armando Cáceres, Diana Velásquez, Cesar Rodríguez, David Morales, Andrea Castillo. (2022).Medicinal plants used in traditional Mayan medicine for the treatment of central nervous system disorders: An overview,Journal of Ethnopharmacology, Volume283,2022,114746,ISSN 0378 8741,https://doi.org/10.1016/j.jep.2021.114746. (https://www.sciencedirect.com/science/article/pii/S0378874121009752)
82. Peña JC. (2002).El concepto de enfermedad y de los padecimientos del riñón en la medicina náhuatl. Síntesis de la medicina precolombina mesoamericana [The concept of illness and kidney diseases in Nahuatl medicine. Synthesis of Mesoamerican pre-Columbian medicine]. Rev Invest Clin. 2002 Sep-Oct;54(5):474-81. Spanish. PMID: 12587423.
83. Geck Matthias S. , Cristians Sol, Berger-González Mónica, Casu Laura , Heinrich Michael , Leonti Marco. (2020). Traditional Herbal Medicine in Mesoamerica:Toward Its Evidence Base for Improving Universal Health Coverage.Frontiers in PharmacologyVolume 11 – 2020. URL=https://www.frontiersin.org/journals/pharmacology/articles/10.3389/fphar.2020.01160. DOI=10.3389/fphar.2020.01160. ISSN=1663-981
84. Formun Altı
85. Viesca, C. (2003). Medicine In Ancient Mesoamerica. In: Selin, H. (eds) Medicine Across Cultures. Science Across Cultures: The History of Non-Western Science, vol 3. Springer, Dordrecht. https://doi.org/10.1007/0-306-48094-8\_13
86. Elferink, Jan. (2015). The Inca healer: Empirical medical knowledge and magic in pre-Columbian Peru. Revista de Indias. 75. 323-350. 10.3989/revindias.2015.011.
87. Miranda Limón JM. (2021).Terapéutica reumatológica en la mesoamérica prehispánica. Reumatol Clin. 2021;17:475–481
88. Chaitanya, Mvnl & Ali, Heyam & Usamo, Firehiwot. (2021). Traditional African Medicine. 10.5772/intechopen.96576.
89. Kasilo OMJ, Wambebe C, Nikiema J-B, et al. (2019).Towards universal health coverage: advancing the development and use of traditional medicines in Africa. BMJ Global Health 2019;4:e001517. doi:10.1136/ bmjgh-2019-001517
90. Mutombo PN, Kasilo OMJ, James PB, et al. (2023).Experiences and challenges of African traditional medicine: lessons from COVID-19 pandemic. BMJ Glob Health 2023;8:e010813. doi:10.1136/ bmjgh-2022-010813
91. Tuasha N, Fekadu S, Deyno S. (2023).Prevalence of herbal and traditional medicine in Ethiopia: a systematic review and meta-analysis of 20-year studies. Syst Rev. 2023 Dec 13;12(1):232. doi: 10.1186/s13643-023-02398-9. PMID: 38093343; PMCID: PMC10717384.
92. Moges, A., & Moges, Y. (2020). Ethiopian Common Medicinal Plants: Their Parts and Uses in Traditional Medicine - Ecology and Quality Control. IntechOpen. doi: 10.5772/intechopen.86202
93. Kebede Feyisa, Malede Berihun Yismaw, Adane Yehualaw, Chernet Tafere, Desalegn Getnet Demsie, Bereket Bahiru, Belayneh Kefale. (2023).Medicinal plants traditionally used to treat human ailments in Ethiopia: A systematic review,Phytomedicine Plus,Volume 4, Issue 1,2024, 100516, ISSN 2667-0313,https://doi.org/10.1016/j.phyplu.2023.100516. (https://www.sciencedirect.com/science/article/pii/S2667031323001124)
94. Philip Clarke. (2008).Aboriginal healing practices and Australian bush medicine. Journal of the Anthropological Society of South Australia Vol. 33 – 2008
95. Devanesen, D. (2000). Traditional Aboriginal Medicine Practice in the Northern Territory. International Symposium on Traditional Medicine. Proceedings of Better Science, Policy & Services for Health Development, held 11-13 September 2000. Kobe, Japan: World Health Organisation Centre for Health Development.
96. Ngaanyatjarra Pitjantjatjara Yankunytjatjara. (2003). Women’s Council Aboriginal Corporation. (ed.) Ngangkari Work – Anangu Way. Traditional Healers of Central Australia. Alice Springs: Ngaanyatjarra Pitjantjatjara Yankunytjatjara Women’s Council Aboriginal Corporation.
97. Patwardhan B, Warude D, Pushpangadan P, Bhatt N. (2005).Ayurveda and traditional Chinese medicine: a comparative overview. Evid Based Complement Alternat Med. 2005 Dec;2(4):465-73. doi: 10.1093/ecam/neh140. Epub 2005 Oct 27. PMID: 16322803; PMCID: PMC1297513.
98. Kim, J.Y.; Pham, D.D.; Koh, B.H. (2011).Comparison of Sasang constitutional medicine, traditional chinese medicine and Ayurveda. Evid.-Based Complementary Altern. Med.  2011, 239659.
99. Hajar R. (2013).The Air of History Part III: The Golden Age in Arab Islamic Medicine An Introduction. Heart Views. 2013 Jan;14(1):43-6. doi: 10.4103/1995-705X.107125. PMID: 23580929; PMCID: PMC3621228.
100. Hawa Edriss, Brittany N. Rosales, Connie Nugent, Christian Conrad, Kenneth Nugent.(2017).Islamic Medicine in the Middle Ages,The American Journal of the Medical Sciences,Volume 354, Issue 3,2017,Pages 223-229,ISSN 0002-9629,<https://doi.org/10.1016/j.amjms.2017.03.021>. (<https://www.sciencedirect.com/science/article/pii/S000296291730157X>)
101. Pua, Isabella A.,(2006). "The Divine Viscera: Medicine and Religion in the Islamic Golden Age" (2016). Young Historians Conference. 11. <https://pdxscholar.library.pdx.edu/younghistorians/2016/oralpres/11>
102. Climate and health: a guide for cross-sector collaboration. Corporate Authors(s) : National Center for Environmental Health (U.S.)Published Date : 08/13/2019. Pages in Document : 48 numbered pages. URL : <https://stacks.cdc.gov/view/cdc/82203>
103. Elendu C. (2024). The evolution of ancient healing practices: From shamanism to Hippocratic medicine: A review. Medicine (Baltimore). 2024 Jul 12;103(28):e39005. doi: 10.1097/MD.0000000000039005. PMID: 38996102; PMCID: PMC11245246.
104. Albert JP, Crubézy E. (2005).Medecine chamanique et modernite medicale [Shamanic healing in the age of modern medicine]. Med Trop (Mars). 2005;65(1):93-9. French. PMID: 15903086.
105. Brigić A, Hasanović M, Pajević I, Aljukić N, Hamidović J, Jakovljević M. (2021).Principles of Hippocratic Medicine from the Perspective of Modern Medicine. Psychiatr Danub. 2021 Spring-Summer;33(Suppl 4):1210-1217. PMID: 35354189.
106. Shaw J.&Sykes N. (2018). New directions in the archeology of medicine: deep time approaches to human-animal-environmental care. World Archeology 50 (3):365-383. <https://doi.org/10.1080/00438243.2018.1574393>
107. Anthropology and Medicine. JAMA. 1998;280(1):101. doi:10.1001/jama.280.1.101-JBK0701-6-1
108. Kabat-Zinn, J. (2003). Mindfulness: The heart of rehabilitation. In Leskowitz, E. (Ed.), Complementary and alternative medicine in rehabilitation (pp. xi–xv). Saint Louis:Churchill Livingstone
109. Verma, Alok. (2023). Buddhism and Vipassana Meditation: A Scientific Method for Mental and Social Growth in the Modern Age. Millah: Journal of Religious Studies. 583-610. 10.20885/millah.vol22.iss2.art11.
110. Buffardi, G, & Martinez Robles Y. A. (2023). Dialogues on the place of creativity in existential therapy. SEA Publ.
111. Li FS, Weng JK. (2017). Demystifying traditional herbal medicine with modern approach. Nat Plants. 2017 Jul 31;3:17109. doi: 10.1038/nplants.2017.109. PMID: 28758992.
112. Montinari MR, Minelli S, De Caterina R. (2019).The first 3500 years of aspirin history from its roots - A concise summary. Vascul Pharmacol. 2019 Feb;113:1-8. doi: 10.1016/j.vph.2018.10.008. Epub 2018 Nov 2. PMID: 30391545.
113. Wachtel-Galor S, Benzie IFF. (2011). Herbal Medicine: An Introduction to Its History, Usage, Regulation, Current Trends, and Research Needs. In: Herbal Medicine: Biomolecular and Clinical Aspects. 2nd edition. CRC Press/Taylor &amp; Francis, Boca Raton (FL); 2011. Available from https://www.ncbi.nlm.nih.gov/books/NBK92773 PMID: 22593939.
114. Junjua, M., Jafar, S., Karamat, F., & Ahmed, F. (2015). From Lab to Pharmacy Shelves: The Story of a Plant Derived Anticancer Drug, "Paclitaxel", Journal of Bioresource Management, 2 (4). DOI: 10.35691/JBM.5102.0038 ISSN: 2309-3854 online
115. Awosika AO, Farrar MC, Jacobs TF. Paclitaxel. [Updated 2023 Nov 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK536917/>
116. Chan, A. S. et al. (2013). A Chinese mind-body exercise improves self-control of children with autism: A randomized controlled trial. PLoS ONE 8(7), e68184
117. Zhang, Y. et al. (2018).The efects of mind-body exercise on cognitive performance in elderly: A systematic review and meta-analysis. Int. J. Environ. Res. Public Health 15(12), 2791
118. Ribeiro, F. & Oliveira, J. (2010).Efect of physical exercise and age on knee joint position sense. Arch. Gerontol. Geriatr. 51(1), 64–67
119. Han, Y.M.Y., Chan, M.M.Y., Choi, C.X.T. *et al. (2023).* The neurobiological effects of mind–body exercise: a systematic review and meta-analysis of neuroimaging studies. *Sci Rep* **13**, 10948 (2023). https://doi.org/10.1038/s41598-023-37309-4
120. Helane´Wahbeh, ND Siegward-M.Elsas, BarryS.Oken (2008). Mind–bodyinterventions ApplicationsinneurologyNeurology®2008;70:2321–232
121. Tienforti, D., Sacco, E., Marangi, F., D’Addessi, A., Racioppi, M., Gulino, G.,…Bassi, P. (2012). Effects of an assisted low-intensity programme of perioperative pelvic floor muscle training in improving the recovery of conti nence after radical prostatectomy: A randomized con trolled trial. Journal of the British Association of Urology International, 110, 1004–1010. http://dx.doi.org/10.1111/ j.1464-410X.2012.10948.x
122. Kelley D. et al. (2012) Mind-Body Therapies: Evidence and Implications in Advanced Oncology PracticeJ Adv Pract Oncol 2012;3:357–373
123. Jones, Richard and Jerome Gellman (2025). "Mysticism", The Stanford Encyclopedia of Philosophy (Summer 2025 Edition), Edward N. Zalta & Uri Nodelman (eds.), forthcoming URL = <https://plato.stanford.edu/archives/sum2025/entries/mysticism/>.
124. Kreps, A. (2018). Reading History with the Essenes of Elmira. *International Journal for the Study of New Religions*, *9*(1), 5-31. <https://doi.org/10.1558/ijsnr.37617>
125. Van Der Kolk, B. (2014). The Body Keeps the Score: Brain, Mind, and Body in the Healing of Trauma. New York, NY: Penguin Books.
126. Ford, Cynthia, (2017). "Reiki and Healing Touch: Implications for Trauma Healing" Capstone Collection. 3069. https://digitalcollections.sit.edu/capstones/3069
127. Potter, Pamela. (2013). Energy Therapies in Advanced Practice Oncology: An Evidence-Informed Practice Approach. Journal of the advanced practitioner in oncology. 4. 139-51. 10.6004/jadpro.2013.4.3.2.
128. Chen Y. (2002).Discussion of Wei Qi-Differential Diagnosis of AIDS. *Chinese Journal of Basic Medicine in Traditional Chinese Medicine*(*Zhongguo Zhongyi Jichu Yixue Zazhi*), 2002;8(4):11-4.
129. Flowers J.(2006). What is qi? Evid Based Complement Alternat Med. 2006 Dec;3(4):551-2. doi: 10.1093/ecam/nel074. Epub 2006 Oct 23. PMID: 17173121; PMCID: PMC1697751.
130. Setiya, Kieran. (2022). "Intention", The Stanford Encyclopedia of Philosophy (Winter 2022 Edition), Edward N. Zalta & Uri Nodelman (eds.), URL = <https://plato.stanford.edu/archives/win2022/entries/intention/>.
131. Radin D, Schlitz M, Baur C. (2015). Distant Healing Intention Therapies: An Overview of the Scientific Evidence. Glob Adv Health Med. 2015 Nov;4(Suppl):67-71. doi: 10.7453/gahmj.2015.012.suppl. Epub 2015 Nov 1. PMID: 26665044; PMCID: PMC4654780.
132. Astin JA, Harkness E, Ernst E. (2000). The efficacy of "distant healing": a systematic review of randomized trials. Ann Intern Med. 2000 Jun 6;132(11):903-10. doi: 10.7326/0003-4819-132-11-200006060-00009. PMID: 10836918.
133. Rajagopal R, Jois SN, Mallikarjuna Majgi S, Anil Kumar MN, Shashidhar HB. (2018).Amelioration of mild and moderate depression through Pranic Healing as adjuvant therapy: randomised double-blind controlled trial. Australas Psychiatry. 2018 Feb;26(1):82-87. doi: 10.1177/1039856217726449. Epub 2017 Aug 24. PMID: 28836826; PMCID: PMC5802541.
134. Jauregui, Maritza & Schuster, Tonya & Clark, M.D. & Jones, Joie. (2012). Pranic Healing: Documenting Use, Expectations, and Perceived Benefits of a Little-Known Therapy in the United States. Journal of Scientific Exploration. 26. 569-588.
135. Tarrant JM, Raines N, Blinne WR.(2019).The Effects of Meditation on Twin Hearts on P300 Values: A Repeated Measures Comparison of Nonmeditators and the Experienced. Integr Med (Encinitas). 2019 Apr;18(2):36-41. PMID: 31341443; PMCID: PMC6601447.
136. Carayannopoulos AG, Han A, Burdenko IN.(2020). The benefits of combining water and land-based therapy. J Exerc Rehabil. 2020 Feb 26;16(1):20-26. doi: 10.12965/jer.1938742.371. PMID: 32161731; PMCID: PMC7056478.
137. Becker, Bruce. (2009). Aquatic Therapy: Scientific Foundations and Clinical Rehabilitation Applications. PM & R : the journal of injury, function, and rehabilitation. 1. 859-72. 10.1016/j.pmrj.2009.05.017.
138. Mooventhan A, Nivethitha L.(2014). Scientific evidence-based effects of hydrotherapy on various systems of the body. N Am J Med Sci. 2014 May;6(5):199-209. doi: 10.4103/1947-2714.132935. PMID: 24926444; PMCID: PMC4049052.
139. Waleed Mohsen Altowairqi, Mohammed Ahmed Alshanbari, Noha Talal Attiah, Mohammed Hassan Radwan, Tahir Mansour Al Jassas, Osamah Hussin Mathkoor, Thabet Muslih Alsufyani, Fahad Muslih Alsufyani, & Fahad Abdullah Alzhrany. (2022). Evaluatıng The Effectıveness Of Aquatıc Therapy In Musculoskeletal Condıtıons. *Journal of Population Therapeutics and Clinical Pharmacology*, *29*(04), 3159-3164. <https://doi.org/10.53555/jptcp.v29i04.5812>
140. Sujatha, K. J., and N. K. Manjunath. 2022. “A Review on Hydrotherapy Practices in Ancient India”. *Journal of Complementary and Alternative Medical Research* 17 (1):22-29. <https://doi.org/10.9734/jocamr/2022/v17i130323>.
141. Barker A:L: et al. (2014).Effectiveness of aquatic exercise for musculoskeletal conditions: a meta-analysis. Archives of physical Medicine and Rehabilitation. 95(9):1776-1786.
142. Waller, B., Ogonowska-Slodownik, A., Vitor, M., Lambeck, J., Daly, D., Kujala, U. M., & Heinonen, A. (2014). Effect of therapeutic aquatic exercise on symptoms and function associated with lower limb osteoarthritis: systematic review with meta-analysis.Physical Therapy. 94(10):1338-1395.
143. Farrell K, Loshak H;(2022).Floatation Therapy for Physical Conditions: CADTH Health Technology Review [Internet]. Ottawa (ON): Canadian Agency for Drugs and Technologies in Health; 2022 Jan. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK595362>
144. Henrykowska G, Soin J, Siermontowski P. (2021).Scuba Diving as a Form of Rehabilitation for People with Physical Disabilities. Int J Environ Res Public Health. 2021 May 26;18(11):5678. doi: 10.3390/ijerph18115678. PMID: 34073170; PMCID: PMC8198635.
145. Lauesen, Torkil. (2021). Riding the wave: Sweden's Integration into the Imperialist World System Riding the Wave Sweden's Integration into the Imperialist World System
146. *Riding the Wave: Workbook*, Treatments That Work (New York, 2008; online edn, Oxford Academic, 1 Jan. 2015), <https://doi.org/10.1093/med:psych/9780195335811.005.0001>,
147. *Gross J. (2008)Emotion regulation. Handbook of Emotions. Ed. Lewis M. Ed. Haviland Jones, JeannetteM and Ed. Felman Barret. Lisa. 3rd ed. New York, NY: The Guilford Press, 2008:497-512.*
148. Abouzed M. Et al. (2020).Urge surfing intervention in patient with chronic atopic dermatitis. Al-Azhar Assiut Medical Journal.18(4):449.
149. Dr. Prabhakaran. B. Selvakumar. K. , Karthick.S., Rubesh. (2023).Effectıveness Of Hot Affusıon Bath Wıth Epsom Salt In Managıng Kneerelated Symptoms Among Patıents Wıth Knee Osteoarthrıtıs- Quası Experımental Study . International Journal of Novel Research and Development Volume 8, Issue 8 August 2023 | ISSN: 2456-4184
150. Ortiz M, Koch AK, Cramer H, Linde K, Rotter G, Teut M, Brinkhaus B, Haller H. (2023).Clinical effects of Kneipp hydrotherapy: a systematic review of randomised controlled trials. BMJ Open. 2023 Jul 9;13(7):e070951. doi: 10.1136/bmjopen-2022-070951. PMID: 37423627; PMCID: PMC10335435.
151. Klaudia Schulte, Sarah B. Blakeslee, Wiebke Stritter, Christine Eidenschink, Peter W. Gündling, Andrea Baumann, Georg Seifert (2021).The effect of Kneipp treatment hydrotherapy on secretory IgA in young children: A controlled, non-randomized clinical pilot study,Complementary Therapies in Medicine,Volume 57,2021,102637,ISSN 0965-2299,https://doi.org/10.1016/j.ctim.2020.102637.(https://www.sciencedirect.com/science/article/pii/S096522992031904X)
152. Shıvanı Bhatıa, Shubhra Saraswat. (2019). Effect Of Japan Water Therapy Infused Wıth Cınnamon On Body Weıght, Waıst/Hıp Ratıo, And Body Mass Index Of Overweıght And Obese Subjects. Asian J Pharm Clin Res, Vol 12, Issue 9, 2019, 302-305
153. Keiko Daidoji. (2009).Water Cures in Japan: The Case of a Health Manual in the Early Nineteenth Century1 Asian Medicine 5 (2009) 80–107
154. Matz H, Orion E, Wolf R. (2003). Balneotherapy in dermatology. Dermatol Ther. 2003;16(2):132-40. doi: 10.1046/j.1529-8019.2003.01622.x. PMID: 12919115.
155. Gálvez I, Torres-Piles S, Ortega-Rincón E.(2018). Balneotherapy, Immune System, and Stress Response: A Hormetic Strategy? Int J Mol Sci. 2018 Jun 6;19(6):1687. doi: 10.3390/ijms19061687. PMID: 29882782; PMCID: PMC6032246.
156. Bhateja, Sumit & Aneja, Vishal & Hassan, Shaik & Arora, Geetika & Aggarwal, Neha. (2022). Balneotherapy in medicine and dentistry: A review. Volume 1. 8-12.
157. Dumitrescu M, Iliescu MG, Mazilu L, Micu SI, Suceveanu AP, Voinea F, Voinea C, Stoian AP, Suceveanu AI. (2022).Benefits of crenotherapy in digestive tract pathology (Review). Exp Ther Med. 2022 Feb;23(2):122. doi: 10.3892/etm.2021.11045. Epub 2021 Dec 7. PMID: 34970345; PMCID: PMC8713159.
158. Georgiou M, Morison G, Smith N, Tieges Z, Chastin S.(2021). Mechanisms of Impact of Blue Spaces on Human Health: A Systematic Literature Review and Meta-Analysis. Int J Environ Res Public Health. 2021 Mar 3;18(5):2486. doi: 10.3390/ijerph18052486. PMID: 33802522; PMCID: PMC7967635.
159. Jie Yin, Jittakon Ramanpong, Jin Chang, Chih-Da Wu, Pei-Hua Chao, Chia-Pin Yu. (2023). Effects of blue space exposure in urban and natural environments on psychological and physiological responses: A within-subject experiment,Urban Forestry & Urban Greening, Volume 87, 2023, 128066, ISSN 1618-8667, https://doi.org/10.1016/j.ufug.2023.128066.
160. Charlier, Roger & Chaineux, Marie-Claire. (2009). The Healing Sea: A Sustainable Coastal Ocean Resource: Thalassotherapy. Journal of Coastal Research - J COASTAL RES. 25. 838-856. 10.2112/08A-0008.1.
161. Mohd Nani SZ, Majid FA, Jaafar AB, Mahdzir A, Musa MN.(2016) Potential Health Benefits of Deep Sea Water: A Review. Evid Based Complement Alternat Med. 2016;2016:6520475. doi: 10.1155/2016/6520475. Epub 2016 Dec 26. PMID: 28105060; PMCID: PMC5221345.
162. Warber SL, Bruyere RL, Weintrub K, Dieppe P.(2015). A Consideration of the Perspectives of Healing Practitioners on Research Into Energy Healing. Glob Adv Health Med. 2015 Nov;4(Suppl):72-8. doi: 10.7453/gahmj.2015.014.suppl. Epub 2015 Nov 1. PMID: 26665045; PMCID: PMC4654782.
163. Levin J. (2011). Energy healers: who they are and what they do. Explore (NY). 2011 Jan-Feb;7(1):13-26. doi: 10.1016/j.explore.2010.10.005. PMID: 21194668.
164. Cuppage J, Baird K, Gibson J, Booth R, Hevey D. (2018). Compassion focused therapy: Exploring the effectiveness with a transdiagnostic group and potential processes of change. Br J Clin Psychol. 2018 Jun;57(2):240-254. doi: 10.1111/bjc.12162. Epub 2017 Oct 17. PMID: 29044607.
165. Maner S, Morris PG, Flewitt BI. (2023).A systematic review of the effectiveness of compassion focused imagery in improving psychological outcomes in clinical and non-clinical adult populations. Clin Psychol Psychother. 2023 Mar;30(2):250-269. doi: 10.1002/cpp.2801. Epub 2022 Dec 8. PMID: 36404411.
166. Lagopoulos J, Xu J, Rasmussen I, Vik A, Malhi GS, Eliassen CF, Arntsen IE, Saether JG, Hollup S, Holen A, Davanger S, Ellingsen Ø. Increased theta and alpha EEG activity during nondirective meditation. J Altern Complement Med. 2009 Nov;15(11):1187-92. doi: 10.1089/acm.2009.0113. PMID: 19922249.
167. Hendricks, Luke ; Bengston, William & Gunkelman, Jay (2010). The Healing Connection: EEG Harmonics, Entrainment, and Schumann's Resonances. Journal of Scientific Exploration 24 (4).
168. Shaw, Saurabh & Mckinnon, Margaret & Heisz, Jennifer & Becker, Suzanna. (2020). Dynamic task-linked switching between brain networks - A Tri-Network perspective. 10.1101/2020.10.19.344101**.**
169. Xie X, Cai C, Damasceno PF, Nagarajan SS, Raj A. (2021).Emergence of canonical functional networks from the structural connectome. Neuroimage. 2021 Aug 15;237:118190. doi: 10.1016/j.neuroimage.2021.118190. Epub 2021 May 19. PMID: 34022382; PMCID: PMC8451304.
170. Yeo BT, Krienen FM, Sepulcre J, Sabuncu MR, Lashkari D, Hollinshead M, Roffman JL, Smoller JW, Zöllei L, Polimeni JR, Fischl B, Liu H, Buckner RL.(2011). The organization of the human cerebral cortex estimated by intrinsic functional connectivity. J Neurophysiol. 2011 Sep;106(3):1125-65. doi: 10.1152/jn.00338.2011. Epub 2011 Jun 8. PMID: 21653723; PMCID: PMC3174820.
171. Han, Y.M.Y., Chan, M.M.Y., Choi, C.X.T. *et al.* (2023).The neurobiological effects of mind–body exercise: a systematic review and meta-analysis of neuroimaging studies. *Sci Rep* **13**, 10948 (2023). <https://doi.org/10.1038/s41598-023-37309-4>
172. Zhang X, Zong B, Zhao W, Li L.(2021). Effects of Mind-Body Exercise on Brain Structure and Function: A Systematic Review on MRI Studies. Brain Sci. 2021 Feb 7;11(2):205. doi: 10.3390/brainsci11020205. PMID: 33562412; PMCID: PMC7915202.
173. Skolasinska P, Basak C, Qin S.(2023). Influence of Strenuous Physical Activity and Cardiorespiratory Fitness on Age-Related Differences in Brain Activations During Varieties of Cognitive Control. Neuroscience. 2023 Jun 1;520:58-83. doi: 10.1016/j.neuroscience.2023.04.007. Epub 2023 Apr 11. PMID: 37054946; PMCID: PMC10234626.
174. Kenta Wakaizumi, Diane Reckziegel, Rami Jabakhanji, A. Vania Apkarian, Marwan N. Baliki. (2023).Influence of exercise on pain is associated with resting-state functional connections: A cross-sectional functional brain imaging study,Neurobiology of Pain,Volume 13,2023,100125,ISSN 2452-073X,https://doi.org/10.1016/j.ynpai.2023.100125. (<https://www.sciencedirect.com/science/article/pii/S2452073X23000120>)
175. Kleemeyer Maike M. , Polk Thad A. , Schaefer Sabine , Bodammer Nils C. , Brechtel Lars , Lindenberger Ulman . (2017).Exercise-Induced Fitness Changes Correlate with Changes in NeuralSpecificity in Older Adults.Frontiers in Human Neuroscience.Volume 11 – 2017. <https://www.frontiersin.org/journals/humanneuroscience/articles/10.3389/fnhum.2017.00123>. DOI=10.3389/fnhum.2017.00123. ISSN=1662-5161
176. Brachman, A., Kamieniarz, A., Michalska, J., Pawłowski, M., Słomka, K. J., & Juras, G. (2017). Balance training programs in athletes.- a systematic review. Journal of Human Kinetics, 58(1), 45-64. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5548151/>
177. Verhagen, E., van der Beek, A., Twisk, J., Bouter, L., Bahr, R., & van Mechelen, W. (2004). The effect of a proprioceptive balance board training program for the prevention of ankle sprains: a prospective controlled trial. The American Journal of Sports Medicine, 32(6), 1385-1393.
178. Taube, W., Gruber, M., & Gollhofer, A. (2008). Spinal and supraspinal adaptations associated with balance training and their functional relevance. Acta Physiologica, 193(2), 101-116.
179. Zech, A., Hübscher, M., Vogt, L., Banzer, W., Hänsel, F., & Pfeifer, K. (2010). Balance training for neuromuscular control and performance enhancement: a systematic review. Journal of Athletic Training, 45(4), 392-403.
180. Lesinski, M., Hortobágyi, T., Muehlbauer, T., Gollhofer, A., & Granacher, U. (2015). Effects of balance training on balance performance in healthy older adults: a systematic review and meta analysis. Sports Medicine, 45(12), 1721-1738.
181. Lubetzky-Vilnai, A., & Kartin, D. (2010).The effect of balance training on balance performance in individuals poststroke: a systematic review. Journal of Neurologic Physical Therapy, 34(3), 127-137.
182. Granacher, U., Gollhofer, A., & Kriemler, S. (2010). Effects of balance training on postural sway, leg extensor strenght and jumping height in adolescents. Research Quarterly for Exercise and Sport, 81(3), 245-251.
183. Alessandra Beggiato Porto, Anderson Nascimento Guimarães, Victor Hugo Alves Okazaki. (2024).The effect of exercise on postural alignment: A systematic review,Journal of Bodywork and Movement Therapies,Volume 40,2024,Pages 99-108,ISSN 1360-8592,https://doi.org/10.1016/j.jbmt.2024.04.004.(<https://www.sciencedirect.com/science/article/pii/S136085922400192X>)
184. Cerciello S, Rossi S, Visonà E, Corona K, Oliva F.(2016). Clinical applications of vibration therapy in orthopaedic practice. Muscles Ligaments Tendons J. 2016 May 19;6(1):147-56. doi: 10.11138/mltj/2016.6.1.147. PMID: 27331044; PMCID: PMC4915454.
185. Lupowitz L.(2022). Vibration Therapy - A Clinical Commentary. Int J Sports Phys Ther. 2022 Aug 1;17(6):984-987. doi: 10.26603/001c.36964. PMID: 36237646; PMCID: PMC9528696.
186. Ellen Zambo Anderson,Chapter 13 - Energy Therapy,Editor(s): Judith E. Deutsch, Ellen Zambo Anderson,Complementary Therapies for Physical Therapy,W.B. Saunders,2008,Pages 196-205,ISBN 9780721601113**,** [**https://doi.org/10.1016/B978-072160111-3.50019-1**](https://doi.org/10.1016/B978-072160111-3.50019-1)**.**
187. Heman-Ackah YD. (2005).Physiology of voice production: considerations for the vocal performer. J Singing. November/December 2005;62:173–176. 7. Behrman A. Common practices of voice therapists in the evaluation of patients. J Voice. 2005;19:454–469.
188. Luong AU, Yong M, Hwang PH, Lin BY, Gopi P, Mohan V, Ma Y, Johnson J, Yen DM, DeMera RS, Bleier BS. (2024).Acoustic resonance therapy is safe and effective for the treatment of nasal congestion in rhinitis: A randomized sham-controlled trial. Int Forum Allergy Rhinol. 2024 May;14(5):919-927. doi: 10.1002/alr.23284. Epub 2023 Oct 9. PMID:
189. Huang TL, Charyton C.(2008).A comprehensive review of the psychological effects of brainwave entrainment. 2008. In: Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews [Internet]. York (UK): Centre for Reviews and Dissemination (UK); 1995-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK75019/
190. Pérez, A., Carreiras, M. & Duñabeitia, J.A. (2017).Brain-to-brain entrainment: EEG interbrain synchronization while speaking and listening. *Sci Rep* **7**, 4190 (2017). <https://doi.org/10.1038/s41598-017-04464-4>
191. Mehar Sahu, Rashmi K. Ambasta, Suman R. Das, Manoj K. Mishra, Anil Shanker, Pravir Kumar. (2024).Harnessing Brainwave Entrainment: A Non-invasive Strategy To Alleviate Neurological Disorder Symptoms,Ageing Research Reviews,Volume 101,2024,102547,ISSN 1568-1637, <https://doi.org/10.1016/j.arr.2024.102547.(https://www.sciencedirect.com/science/article/pii/S1568163724003659)>
192. Kotera Y, Beaumont J, Edwards AM, Cotterill M, Kirkman A, Tofani AC, McPhilbin M, Takhi S, Barnes K, Todowede O, Ingall BR, Asano K, Arimitsu K. (2024).A Narrative Review of Compassion Focused Therapy on Positive Mental Health Outcomes. Behav Sci (Basel). 2024 Jul 25;14(8):643. doi: 10.3390/bs14080643. PMID: 39199039; PMCID: PMC11351419.
193. Hope, Terrie. (2017). The Effects of Access Bars on Anxiety and Depression. 9. 10.9769/EPJ.2017.9.2.TH.
194. Ropers, Jean-Yves & Rohon, Isabelle. (2013). [A therapy bar: a concrete example of treatment]. Soins. Psychiatrie. 34-6.
195. An, Gq., Yu, Xf. (2010). Medicine bar percussion therapy and its clinical application. *J. Acupunct. Tuina. Sci.* **8**, 328–330 https://doi.org/10.1007/s11726-010-0441-9
196. FREITAG, V. L. (2020). Integrative and Complementary Practices: access bars to consciousness as a health care strategy. Research, Society and Development, *[S. l.]*, v. 9, n. 8, p. e24985221, DOI: 10.33448/rsd-v9i8.5221. Disponível em: <https://rsdjournal.org/index.php/rsd/article/view/5221>.
197. Dumas, H. R. (2023). Tāqat, Shakti or Empowerment(s)? Describing the Experience of Power: A Decade of Observations in one Informal Settlement of Patna, India. *Journal of South Asian Development*, *18*(2), 221-243. <https://doi.org/10.1177/09731741231151292> (Original work published 2023)
198. Navsaria, N., & Petersen, S. (2007). Finding a voice in *Shakti*: A therapeutic approach for Hindu Indian women. *Women & Therapy, 30*(3-4), 161–175. [https://doi.org/10.1300/J015v30n03\_12](https://psycnet.apa.org/doi/10.1300/J015v30n03_12)
199. SK, Sajal & M, Mondal. (2015). An Intensive Research Study on Rheumatoid Arthritis through Yoga Shakti (A Drugless Therapy). Journal of Womens Health Care. 04. 10.4172/2167-0420.1000263.
200. Sreedhar C, Ra A, Prayaga A, Augusthy P, Joseph D, Catherin N, Silwal K, Nair PM. (2024).An Overview of the Naturopathic Medicine Protocol Used in Inpatient Yoga and Naturopathy Hospitals in India: The Prakriti Shakti Protocol. J Lifestyle Med. 2024 Aug 31;14(2):88-93. doi: 10.15280/jlm.2024.14.2.88. PMID: 39280942; PMCID: PMC11391336.
201. Cai DC, Chen CY, Lo TY. (2022).Foot Reflexology: Recent Research Trends and Prospects. Healthcare (Basel). 2022 Dec 20;11(1):9. doi: 10.3390/healthcare11010009. PMID: 36611469; PMCID: PMC9819031.
202. Langevin HM. (2006).Connective tissue: a body-wide signaling network? Med Hypotheses. 2006;66(6):1074-7. doi: 10.1016/j.mehy.2005.12.032. Epub 2006 Feb 17. PMID: 16483726.
203. Findley, Thomas, W.,and Shalwala, Mona. (2013). “Fascia Research Congress Evidence from the 100 year perspective of Andrew Taylor Still”; Journal Of Bodywork & Movement Therapies; (2013)17, 356-364
204. Judith Whatley, Joanne Perkins, Carol Samuel. (2022).‘Reflexology: Exploring the mechanism of action’,Complementary Therapies in Clinical Practice,Volume 48,2022,101606,ISSN 1744-3881,https://doi.org/10.1016/j.ctcp.2022.101606.(<https://www.sciencedirect.com/science/article/pii/S1744388122000743>)
205. Engmann B.(2024). Social issues relating to Vladimir Bekhterev's concept of reflexology: a hitherto underestimated aspect of his work. Hist Psychiatry. 2024 Sep;35(3-4):347-354. doi: 10.1177/0957154X241254224. Epub 2024 Jun 11. PMID: 38863269; PMCID: PMC11363463.
206. Gablonski, T.-C., Senft, B., & Andreas, S. (2022). Level of Structural Integration and Its Association with Intersession Experiences and Outcomes: A Pilot Study. International Journal of Environmental Research and Public Health, 19(15), 9254. https://doi.org/10.3390/ijerph19159254
207. Jacobson E. (2011).Structural integration, an alternative method of manual therapy and sensorimotor education. J Altern Complement Med. 2011 Oct;17(10):891-9. doi: 10.1089/acm.2010.0258. Epub 2011 Oct 12. PMID: 21992437; PMCID: PMC3198617.
208. Gevers-Montoro C, Provencher B, Descarreaux M, Ortega de Mues A, Piché M. (2021). Clinical Effectiveness and Efficacy of Chiropractic Spinal Manipulation for Spine Pain. Front Pain Res (Lausanne). 2021 Oct 25;2:765921. doi: 10.3389/fpain.2021.765921. PMID: 35295422; PMCID: PMC8915715
209. Lefebvre R, Peterson D, Haas M. (2012).Evidence-Based Practice and Chiropractic Care. J Evid Based Complementary Altern Med. 2012 Dec 28;18(1):75-79. doi: 10.1177/2156587212458435. PMID: 23875117; PMCID: PMC3716373.
210. Edzard Ernst. (2007).,Chiropractic: A Critical Evaluation,Journal of Pain and Symptom Management,Volume 35, Issue 5,2008,Pages 544- 562, ISSN 0885 3924,https://doi.org/10.1016/j.jpainsymman.2007.07.004.

(https://www.sciencedirect.com/science/article/pii/S088539240700783X)

1. Trager, R. J., Bejarano, G., Perfecto, R.-P. T., Blackwood, E. R., & Goertz, C. M. (2024). Chiropractic and Spinal Manipulation: A Review of Research Trends, Evidence Gaps, and Guideline Recommendations. *Journal of Clinical Medicine*, *13*(19), 5668. https://doi.org/10.3390/jcm13195668
2. Kerry, Roger, Young, Kenneth, Evans, David, Lee, Edward, Georgopoulos, Vasileios, Meakins, Adam, McCarthy, Christopher, Cook, Chad, Ridehalgh, Colette et al (2024) A modern way to teach and practice manual therapy. Chiropractic & Manual Therapies, 32 (17)
3. Bizzarri, Paolo & Foglia, Andrea. (2020). Manual Therapy: Art or Science?. 10.5772/intechopen.90730.
4. Steven Piper, Heather M. Shearer, Pierre Côté, Jessica J. Wong, Hainan Yu, Sharanya Varatharajan, Danielle Southerst, Kristi A. Randhawa, Deborah A. Sutton, Maja Stupar, Margareta C. Nordin, Silvano A. Mior, Gabrielle M. van der Velde, Anne L. Taylor-Vaisey. (2016).The effectiveness of soft-tissue therapy for the management of musculoskeletal disorders and injuries of the upper and lower extremities: A systematic review by the Ontario Protocol for Traffic Injury management (OPTIMa) collaboration,Manual Therapy,Volume 21,2016,Pages 18-34,ISSN 1356 689X, https://doi.org/10.1016/j.math.2015.08.011.(https://www.sciencedirect.com/science/article/pii/S1356689X15001745)
5. Jurecka A, Papież M, Skucińska P, Gądek A.(2021). Evaluating the Effectiveness of Soft Tissue Therapy in the Treatment of Disorders and Postoperative Conditions of the Knee Joint-A Systematic Review. J Clin Med. 2021 Dec 18;10(24):5944. doi: 10.3390/jcm10245944. PMID: 34945240; PMCID: PMC8704673.
6. Vickers A, Zollman C, Reinish JT.(2001). Massage therapies. West J Med. 2001 Sep;175(3):202–4. PMCID: PMC1071543.
7. Koren Y, Kalichman L. (2018).Deep tissue massage: What are we talking about? J Bodyw Mov Ther. 2018 Apr;22(2):247-251. doi: 10.1016/j.jbmt.2017.05.006. Epub 2017 May 17. PMID: 29861215.
8. Yogev Koren, Leonid Kalichman. (2018).Deep tissue massage: What are we talking about?,Journal of Bodywork and Movement Therapies,Volume 22, Issue 2,2018,Pages 247-251,ISSN 1360-8592, https://doi.org/10.1016/j.jbmt.2017.05.006. (https://www.sciencedirect.com/science/article/pii/S1360859217301067)
9. Plancke, Carine. (2019). Yoni touch and talk: Sacralizing the female sex through tantra. Sexualities. 23. 136346071986183. 10.1177/1363460719861832.
10. Ventegodt et al.. (2006).Clinical Holistic Medicine (34) TheScientificWorldJOURNAL (2006) 6, 2066–2079
11. Isernia, Sara & Rossetto, Federica & Blasi, Valeria & Massaro, Davide & Castelli, Ilaria & Ricci, Cristian & Shamay-Tsoory, Simone & Marchetti, Antonella & Baglio, Francesca. (2022). Measuring cognitive and affective Theory of Mind with the Italian Yoni task: normative data and short versions. Current Psychology. 42. 10.1007/s12144-022-03457-5.
12. sex.”(White, 2001
13. Czerniak-Drożdżowicz, Marzenna. (2018). Rituals of the Tantric traditions of South India – the text (canon, rule) versus the practice. Studia Religiologica. Tom 47, nr 4, p. 253-262.
14. Kakati, Nilam. (2017). Vestıgıal practıces of tantrıc tradıtıon: an analysıs of yoga and ıts survıval. International Journal of Advanced Research. 5. 2709-2712. 10.21474/IJAR01/5014.
15. Lafortune D, Girard M, Dussault É, Philibert M, Hébert M, Boislard MA, Goyette M, Godbout N.(2023). Who seeks sex therapy? Sexual dysfunction prevalence and correlates, and help-seeking among clinical and community samples. PLoS One. 2023 Mar 6;18(3):e0282618. doi: 10.1371/journal.pone.0282618. PMID: 36877709; PMCID: PMC9987801.
16. Center for Substance Abuse Treatment. Brief Interventions and Brief Therapies for Substance Abuse. Rockville (MD): Substance Abuse and Mental Health Services Administration (US); 1999. (Treatment Improvement Protocol (TIP) Series, No. 34.) Chapter 6 --Brief Humanistic and Existential Therapies. Available from: https://www.ncbi.nlm.nih.gov/books/NBK64939/
17. Søren Ventegodt1,Niels Jørgen Andersen, and Joav Merrick. (2003).Holistic Medicine IV: Principles of Existential Holistic Group Therapy and the Holistic Process of Healing in a Group SettingResearch Article TheScientificWorldJOURNAL (2003) 3, 1388–1400 ISSN 1537-744X; DOI 10.1100/tsw.2003.124
18. Lohrey A, Boreham B. (2021).Lifting the veil on Bohm's holomovement. Commun Integr Biol. 2021 Nov 22;14(1):221-229. doi: 10.1080/19420889.2021.2001157. PMID: 34858545; PMCID: PMC8632281.
19. Farman, Abou. (2022) 2023. “Transhumanism”. In *The Open Encyclopedia of Anthropology*, edited by Felix Stein. Facsimile of the first edition in *The Cambridge Encyclopedia of Anthropology*. Online: <http://doi.org/10.29164/22transhumanism>
20. Ji, S., Xiong, M., Chen, H. *et al.* (2023).Cellular rejuvenation: molecular mechanisms and potential therapeutic interventions for diseases. *Sig Transduct Target Ther* 8, 116 (2023). https://doi.org/10.1038/s41392-023-01343-5
21. João Pedro de Magalhães, Alejandro Ocampo. (2022).Cellular reprogramming and the rise of rejuvenation biotech,Trends in Biotechnology,Volume 40, Issue 6,2022,

Pages 639-642,ISSN 0167-7799, https://doi.org/10.1016/j.tibtech.2022.01.011.(<https://www.sciencedirect.com/science/article/pii/S0167779922000257>)

1. Shuaifei Ji , Mingchen Xiong , Huating Chen, Yiqiong Liu , Laixian Zhou , Yiyue Hong , Mengyang Wang , Chunming Wang , Xiaobing Fu and Xiaoyan Sun. (2023).Signal Cellular rejuvenation: molecular mechanisms and potential therapeutic interventions for diseases Transduction and Targeted Therapy (2023) 8:116
2. Lee, Lik Chuan & Wall, Samuel & Klepach, Doron & Ge, Lijuan & Zhang, Zhihong & Lee, Randall & Hinson, Andy & Gorman III, Joseph & Guccione, Julius. (2013). Algisyl-LVR (TM) with coronary artery bypass grafting reduces left ventricular wall stress and improves function in the failing human heart. International journal of cardiology. 168. 10.1016/j.ijcard.2013.01.003.
3. Atala A. Regenerative medicine strategies. J Pediatr Surg. 2012 Jan;47(1):17-28. doi: 10.1016/j.jpedsurg.2011.10.013. PMID: 22244387.
4. Igwe N, Patel NC, Aijaz T. Regenerative Therapy in Pain. [Updated 2023 Jan 16]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK578202/>
5. Mao AS, Mooney DJ. (2015).Regenerative medicine: Current therapies and future directions. Proc Natl Acad Sci U S A. 2015 Nov 24;112(47):14452-9. doi: 10.1073/pnas.1508520112. PMID: 26598661; PMCID: PMC4664309.
6. Gary Fryer. (2011).Muscle energy technique: An evidence-informed approach,International Journal of Osteopathic Medicine,Volume 14, Issue 1,2011,Pages 3-9,ISSN 1746-0689, <https://doi.org/10.1016/j.ijosm.2010.04.004.(https://www.sciencedirect.com/science/article/pii/S1746068910000301)>
7. Talley JT, Goto KK. (2025).Osteopathic Manipulative Treatment: Muscle Energy Procedure With Post-Isometric Relaxation - Thoracic Vertebrae. [Updated 2023 Sep 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK560895/>
8. Waxenbaum JA, Woo MJ, Lu M. Physiology, Muscle Energy. [Updated 2024 Jan 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK559029/>
9. Thomas, E., Cavallaro, A.R., Mani, D. *et al.* (2019).The efficacy of muscle energy techniques in symptomatic and asymptomatic subjects: a systematic review. *Chiropr Man Therap* **27**, 35 (2019). <https://doi.org/10.1186/s12998-019-0258-7>
10. Jeremy D Wong,Tyler Cluff Arthur D Kuo(2021) The energetic basis for smooth human arm movements*eLife* 10:e68013. <https://doi.org/10.7554/eLife.68013>
11. Potop V, Mihailescu LE, Mihaila I, Zawadka-Kunikowska M, Jagiello W, Chernozub A, Baican M – S, Timnea OC, Ene Voiculescu C, Ascinte A. (2024).Applied biomechanics within the Kinesiology discipline in higher education . *Physical Education of Students*. 2024;28(2):106-19. <https://doi.org/10.15561/20755279.2024.0208>
12. Sorgente V, Minciacchi D.(2023). Efficiency in Kinesiology: Innovative Approaches in Enhancing Motor Skills for Athletic Performance. J Funct Morphol Kinesiol. 2023 Aug 4;8(3):111. doi: 10.3390/jfmk8030111. PMID: 37606406; PMCID: PMC10443250.
13. Ingrid Maine, Anita Julieanne Horvath, Phyllis Lau. (2022).,‘Touch for Health’ based kinesiology interventions: An innovative qualitative research exploring clients' perspectives,Complementary Therapies in Clinical Practice,Volume 49,2022,101643,ISSN 1744-3881,https://doi.org/10.1016/j.ctcp.2022.101643. (https://www.sciencedirect.com/science/article/pii/S1744388122001116)
14. Sporis, Goran & Badric, Marko & Prskalo, Ivan & Bonacin, Dobromir. (2013). Kinesiology - Systematic review. Sport Science. 1. 7-23.
15. Hall, Sue & Lewith, George & Brien, Sarah & Little, Paul. (2008). A Review of the Literature in Applied and Specialised Kinesiology. Forschende Komplementärmedizin (2006). 15. 40-6. 10.1159/000112820.
16. Schwartz, Stephan. (2014). Applıed kınesıology. Explore. The Journal of Science and Healing. 10. 217-217.
17. Conboy L, Edshteyn I, Garivaltis H.(2009). Ayurveda and Panchakarma: measuring the effects of a holistic health intervention. ScientificWorldJournal. 2009 Apr 27;9:272-80. doi: 10.1100/tsw.2009.35. PMID: 19412555; PMCID: PMC2699273.
18. Uthamaroyan, C.S., Anaivaari R Anandan (eds.) (2005): A compendium of Siddha medicine. Department of Indian Medicine & Homoeopathy, Government of Tamilnadu, Chennai.
19. Gannewar, Ms & Tiwari, Mr. (2023). Siddha System of Medicine. International Journal for Research in Applied Science and Engineering Technology. 11. 1715-1718. 10.22214/ijraset.2023.55330.
20. Janani L. et al. (2017). International Journal of Research in Pharmaceutical and Nano Sciences. 6(1), 2017, 16 - 25
21. S. Karthik Nagarajan, A. Vasanth Miltonraj, N. J. Muthukumar, P.Samundeeswari, V. Mahalakshmi, V. Vasanth Miltonraj, Banumathi. (2018). Brief Discrimination of Varmam in Siddha System of Medicine. Int. J. Curr. Res. Med. Sci. 4(1): 10-17. DOI: http://dx.doi.org/10.22192/ijcrms.2018.04.01.002
22. Arvind Kumar Yadav, Rita Marwaha, Nisha Bhalerao, Swatantra Kumar Chourasia, Shradhha Sharma.(2022). Pain management through Marma Chikitsa. J Ayurveda Integr Med Sci 2022;2:69-76.
23. Mishra, Alka & Shrivastava, Vandana. (2021). Exploring the Science of Marma - An Ancient Healing Technique: Definition and Properties of Marma. Dev Sanskriti Interdisciplinary International Journal. 18. 46-63. 10.36018/dsiij.v18i.155.
24. Negi, Vineeta & Susheela, Parvat & Anju, Vyas & Pandoh, Jaral. (2018). Marma and Marma Therapy: A Review. World Journal of Pharmaceutical Research. 7. 258-271. 10.20959/wjpr201815-12973.
25. Cooper, David & Lindahl, Jared & Palitsky, Roman & Britton, Willoughby. (2021). “Like a Vibration Cascading through the Body”: Energy-Like Somatic Experiences Reported by Western Buddhist Meditators. Religions. 12. 1042. 10.3390/rel12121042.
26. Dhuri KD, Bodhe PV, Vaidya AB. Shirodhara. (2013). A psycho-physiological profile in healthy volunteers. J Ayurveda Integr Med. 2013 Jan;4(1):40-4. doi: 10.4103/0975-9476.109550. PMID: 23741161; PMCID: PMC3667433.
27. Kumawat, Achala. (2024). Unique modality of stress management- Shirodhara: A review. International Journal of Green Pharmacy. 18. 157. 10.22377/ijgp.v18i03.3590.
28. Arya, P. Y., Craig, S. R., Dorje, G., Ga, Y., Garrett, F., Gerke, B., Gyatso, J., Hofer, T., Larsen, K., Sabernig, K., Samuel, G., Saxer, M., Yoeli-Tlalim, R., & Vasstveit, I. K. (2014). *Bodies in Balance: The Art of Tibetan Medicine* (T. HOFER, Ed.). University of Washington Press. http://www.jstor.org/stable/j.ctvcwn8hk
29. Roberti di Sarsina P, Ottaviani L, Mella J. Tibetan medicine. (2011). Unique heritage of person-centered medicine. EPMA J. 2011 Dec;2(4):385-9. doi: 10.1007/s13167-011-0130-x. Epub 2011 Nov 12. PMID: 23194325; PMCID: PMC3405412.
30. Cacioppo JT, Berntson GG, Decety J.(2010). Socıal neuroscıence and ıts relatıonshıp to socıal psychology. Soc Cogn. 2010;28(6):675-685. doi: 10.1521/soco.2010.28.6.675. PMID: 24409007; PMCID: PMC3883133.
31. Ulberg, R., Ness, E., Dahl, HS.J. *et al.* (2016).Relational interventions in psychotherapy: development of a therapy process rating scale. *BMC Psychiatry* **16**, 310 (2016). https://doi.org/10.1186/s12888-016-1021-4
32. Greenman, P. S., Johnson, S. M., & Wiebe, S. (2019). Emotionally focused therapy for couples: At the heart of science and practice. In B. H. Fiese, M. Celano, K. Deater-Deckard, E. N. Jouriles, & M. A. Whisman (Eds.), *APA handbook of contemporary family psychology: Family therapy and training* (pp. 291–305). American Psychological Association. [https://doi.org/10.1037/0000101-018](https://psycnet.apa.org/doi/10.1037/0000101-018)
33. Tremblay, M.-P. B., Tuerk, C., Jackson, P. L., & Beauchamp, M. H. (2023). Social neuroscience. In G. G. Brown, B. Crosson, K. Y. Haaland, & T. Z. King (Eds.), *APA handbook of neuropsychology: Neuroscience and neuromethods* (pp. 177–195). American Psychological Association. [https://doi.org/10.1037/0000308-009](https://psycnet.apa.org/doi/10.1037/0000308-009)
34. Bosmans G, Borelli JL.(2022). Attachment and the Development of Psychopathology: Introduction to the Special Issue. Brain Sci. 2022 Jan 28;12(2):174. doi: 10.3390/brainsci12020174. PMID: 35203937; PMCID: PMC8870158.
35. Cassidy J, Jones JD, Shaver PR.(2013). Contributions of attachment theory and research: a framework for future research, translation, and policy. Dev Psychopathol. 2013 Nov;25(4 Pt 2):1415-34. doi: 10.1017/S0954579413000692. PMID: 24342848; PMCID: PMC4085672.
36. Fischer DJ, Fink BC. (2014).Clinical processes in behavioral couples therapy. Psychotherapy (Chic). 2014 Mar;51(1):11-4. doi: 10.1037/a0033823. Epub 2013 Dec 30. PMID: 24377400; PMCID: PMC4766977.
37. Nichols, Michael & Colapinto, Jorge. (2017). Enactment in Structural Family Therapy. 10.1007/978-3-319-15877-8\_969-1.
38. Kula, Ofra & Machluf, Reut & Shahar, Ben & Greenberg, Leslie & Bar-Kalifa, Eran. (2023). The effect of therapists' enactment interventions in promoting vulnerability sharing in emotion focused couple therapy. Psychotherapy research : journal of the Society for Psychotherapy Research. 34. 1-12. 10.1080/10503307.2023.2245961.
39. Rucińska Zuzanna , Fondelli Thomas. (2022). Enacting Metaphors in Systemic Collaborative TherapyFrontiers in Psychology Volume 13 – 2022 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.867235DOI=10.3389/fpsyg.2022.867235ISSN=1664-1078
40. Chapman AL.(2006). Dialectical behavior therapy: current indications and unique elements. Psychiatry (Edgmont). 2006 Sep;3(9):62-8. PMID: 20975829; PMCID: PMC2963469.
41. Williams, L. M., & Hiebert, W. J. (2001). Challenging the Belief System Behind Enmeshment. *Journal of Clinical Activities, Assignments & Handouts in Psychotherapy Practice*, *1*(2), 17–28. <https://doi.org/10.1300/J182v01n02_02>
42. Cristina M.C. Baroncelli, Paul Lodder, Marije van der Lee, Nathan Bachrach,The role of enmeshment and undeveloped self, subjugation and self-sacrifice in childhood trauma and attachment related problems: The relationship with self-concept clarity,Acta Psychologica, Volume 254, 2025, 104839, ISSN 0001-6918,https://doi.org/10.1016/j.actpsy.2025.104839. (<https://www.sciencedirect.com/science/article/pii/S0001691825001520>)
43. Bacon, Ingrid & Conway, Jeff. (2022). Co-dependency and Enmeshment — a Fusion of Concepts. International Journal of Mental Health and Addiction. 21. 10.1007/s11469-022-00810-4.
44. Carbon CC, Albrecht S. (2012).Bartlett's schema theory: the unreplicated "portrait d'homme" series from 1932. Q J Exp Psychol (Hove). 2012;65(11):2258-70. doi: 10.1080/17470218.2012.696121. Epub 2012 Sep 13. PMID: 22974006.
45. Meylani, Rusen. (2024). Innovations With Schema Theory: Modern Implications for Learning, Memory, And Academic Achievement. International Journal For Multidisciplinary Research. 6. 10.36948/ijfmr.2024.v06i01.13785.
46. Jeong S, Clyburn J, Bhatia NS, McCourt J, Lemons PP. (2022).Student Thinking in the Professional Development of College Biology Instructors: An Analysis through the Lens of Sociocultural Theory. CBE Life Sci Educ. 2022 Jun;21(2):ar30. doi: 10.1187/cbe.21-01-0003. PMID: 35580006; PMCID: PMC9508914.
47. Rahmatirad, Mahbobeh. (2020). A Review of Socio-Cultural Theory. SIASAT. 4. 23-31. 10.33258/siasat.v4i3.66
48. Kurniawan, Citra & Kusumaningrum, Shirly & Lam, Kee-Fui Turner & Surahman, Ence. (2022). Improving Language Teaching and Learning Process with Dual Coding Theory Approaches. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan. 7. 281. 10.17977/jptpp.v7i8.15313.
49. Liu, X., Liu, C.-H., & Li, Y. (2020). The Effects of Computer-Assisted Learning Based on Dual Coding Theory. Symmetry, 12(5), 701. <https://doi.org/10.3390/sym12050701>
50. Kanellopoulou, C., Kermanidis, K. L., & Giannakoulopoulos, A. (2019). The Dual-Coding and Multimedia Learning Theories: Film Subtitles as a Vocabulary Teaching Tool. *Education Sciences*, *9*(3), 210.

<https://doi.org/10.3390/educsci9030210>

1. Wooten J:O: &Cuevas JA. (2024). The effects of dual coding theory on social studies vocabulary and comprehension in elementary education. International Journal on Social and Education Sciences (IJon SES). 6(4):673-691. <https://doi.org/10.46328/ijonses.696>.
2. Olafsen A. & Deci E. (2020). Self determination Theory and its relation to organizations. Oxford Research Encyclopedia of Psychology. Retireved 20 May 2025, from https://oxfordre.com/psychology/view/10.1093/acrefore/9780190236557.001.0001/acrefore-9780190236557-e-112.
3. Sansone, Carol & Tang, Yun. (2021). Intrinsic and Extrinsic Motivation and Self-Determination Theory. Motivation Science. 7. 113-114. 10.1037/mot0000234.
4. Werdhiastutie, Any & Suhariadi, Fendy & Partiwi, Sri. (2020). Achievement Motivation as Antecedents of Quality Improvement of Organizational Human Resources. Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences. 3. 747-752. 10.33258/birci.v3i2.886.
5. Christina M. Moran, James M. Diefendorff, Tae-Yeol Kim, Zhi-Qiang Liu,A profile approach to self-determination theory motivations at work,Journal of Vocational Behavior,Volume 81, Issue 3,2012,Pages 354-363,ISSN 0001-8791,https://doi.org/10.1016/j.jvb.2012.09.002. (<https://www.sciencedirect.com/science/article/pii/S0001879112001339>)
6. Garima Salonia et al.(2021). Codependency and Coping Strategies in the Spouses of Substance Abusers. Sch J App Med Sci, 2021 July 9(7): 1130-1138.
7. Vlaicu, Claudia & Aurica, Haidu. (2020). CO-DEPENDENCY IN INTIMATE RELATIONSHIP-A LEARNED BEHAVIOUR. International Journal of Theology, Philosophy and Science. 4. 82-89. 10.26520/ijtps.2020.4.6.82-89.
8. Bacon, Ingrid & Mckay, Elizabeth & Reynolds, Frances & McIntyre, Anne. (2020). The Lived Experience of Codependency: an Interpretative Phenomenological Analysis. International Journal of Mental Health and Addiction. 18. 10.1007/s11469-018-9983-8.
9. Powers MB, Zum Vorde Sive Vording MB, Emmelkamp PM. (2009). Acceptance and commitment therapy: a meta-analytic review. In: Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews [Internet]. York (UK): Centre for Reviews and Dissemination (UK); 1995-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK77765/
10. Larmar, Stephen & Wiatrowski, Stanislaw & Lewis-Driver, Stephen. (2014). Acceptance & Commitment Therapy: An Overview of Techniques and Applications. Journal of Service Science and Management. 07. 216-221. 10.4236/jssm.2014.73019
11. Courtney-Seidler, E. A., Burns, K., Zilber, I., & Miller, A. L. (2014). Adolescent suicide and self-injury: Deepening the understanding of the biosocial theory and applying dialectical behavior therapy. *International Journal of Behavioral Consultation and Therapy, 9*(3), 35–40. [https://doi.org/10.1037/h0101638](https://psycnet.apa.org/doi/10.1037/h0101638)
12. Crowell SE, Beauchaine TP, Linehan MM.(2009). A biosocial developmental model of borderline personality: Elaborating and extending Linehan's theory. Psychol Bull. 2009 May;135(3):495-510. doi: 10.1037/a0015616. PMID: 19379027; PMCID: PMC2696274.
13. Nicole Musser, Maureen Zalewski, Stephanie Stepp, Jennifer Lewis,A systematic review of negative parenting practices predicting borderline personality disorder: Are we measuring biosocial theory's ‘invalidating environment’?,Clinical Psychology Review,Volume 65,2018, Pages 1-16, ISSN 0272-7358,https://doi.org/10.1016/j.cpr.2018.06.003.
14. Hou, K., Wu, ZX., Chen, XY. *et al.* (2022).Microbiota in health and diseases. *Sig Transduct Target Ther* **7**, 135 (2022). https://doi.org/10.1038/s41392-022-00974-4
15. Yaqub, M. O., Jain, A., Joseph, C. E., & Edison, L. K. (2025). Microbiome-Driven Therapeutics: From Gut Health to Precision Medicine. Gastrointestinal Disorders, 7(1), 7. https://doi.org/10.3390/gidisord7010007
16. Allegretti JR, Khanna S, Mullish BH, Feuerstadt P. (2024).The Progression of Microbiome Therapeutics for the Management of Gastrointestinal Diseases and Beyond. Gastroenterology. 2024 Oct;167(5):885-902. doi: 10.1053/j.gastro.2024.05.004. Epub 2024 May 14. PMID: 38754739.
17. Sorbara, M.T., Pamer, E.G. (2022).Microbiome-based therapeutics. *Nat Rev Microbiol* 20, 365–380 (2022). <https://doi.org/10.1038/s41579-021-00667-9>
18. Gulliver EL, Young RB, Chonwerawong M, D'Adamo GL, Thomason T, Widdop JT, Rutten EL, Rossetto Marcelino V, Bryant RV, Costello SP, O'Brien CL, Hold GL, Giles EM, Forster SC. (2022).Review article: the future of microbiome-based therapeutics. Aliment Pharmacol Ther. 2022 Jul;56(2):192-208. doi: 10.1111/apt.17049. Epub 2022 May 24. PMID: 35611465; PMCID: PMC9322325.
19. Alam Md Zahidul , Maslanka Jeffrey R. , Abt Michael C. Immunological consequences of microbiome-based therapeutics,Frontiers in Immunology, Volume 13 – 2022,2023 <https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2022.1046472>, DOI=10.3389/fimmu.2022.1046472, ISSN=1664-3224
20. Yadav G, McNamara S, Gunturu S. [Updated 2024 Aug 16]. Trauma-Informed Therapy. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK604200/>
21. Lambert, J. E., & Alhassoon, O. M. (2014). Trauma-Focused Therapy for Refugees: Meta-Analytic Findings. Journal of Counseling Psychology. Advance online publication. http://dx.doi.org/10.1037/cou0000048
22. Judith A. Cohen & Anthony P. Mannarino (2008).Child and Adolescent Mental Health Volume 13, No. 4, 2008, pp. 158–162
23. Basford, Amy Beth,. (2008)."Applying and adapting testimonial psychotherapy to address the effects of racebased traumatic stress on people of color in the United States" (2008). Masters Thesis, Smith College, Northampton, MA. https://scholarworks.smith.edu/theses/1305
24. van Dijk JA, Schoutrop MJ, Spinhoven P. (2003).Testimony therapy: treatment method for traumatized victims of organized violence. Am J Psychother. 2003;57(3):361-73. doi: 10.1176/appi.psychotherapy.2003.57.3.361. PMID: 12961820.
25. Esala JJ, Taing S. (2017).Testimony Therapy With Ritual: A Pilot Randomized Controlled Trial. J Trauma Stress. 2017 Feb;30(1):94-98. doi: 10.1002/jts.22163. Epub 2017 Jan 13. PMID: 28084662.
26. Igreja V. et al. (2004). Testimony method to ameliorate post-traumatic stress symptoms: Community based intervention study with Mozambican çivil war survivors. British Journal of Psychiatry. 2004; 184(3):251-257. Doi.10.1192/bjp.184.3.251.204-17.
27. Jordan L.S., et al. (2021). A sociopolitical response to vicarious witnessing : testimonial therapy. Journal of Ethnic & Cultural diversity in social Work. 32(5):268-272. <https://doi.org/10.1080/15313204.2021.1990816>
28. Brewin CR, Burgess N. (2014).Contextualisation in the revised dual representation theory of PTSD: a response to Pearson and colleagues. J Behav Ther Exp Psychiatry. 2014 Mar;45(1):217-9. doi: 10.1016/j.jbtep.2013.07.011. Epub 2013 Aug 6. PMID: 24041427; PMCID: PMC3857594.
29. Lely JCG, Smid GE, Jongedijk RA, W Knipscheer J, Kleber RJ. (2019).The effectiveness of narrative exposure therapy: a review, meta-analysis and meta-regression analysis. Eur J Psychotraumatol. 2019 Mar 25;10(1):1550344. doi: 10.1080/20008198.2018.1550344. PMID: 31007868; PMCID: PMC6450467.
30. Catriona Craig, Syd Hiskey & Aimee Spector (2020): Compassion Focused Therapy: a systematic review of its effectiveness and acceptability in clinical populations, Expert Review of Neurotherapeutics, DOI: 10.1080/14737175.2020.1746184
31. Shapiro F.(2014). The role of eye movement desensitization and reprocessing (EMDR) therapy in medicine: addressing the psychological and physical symptoms stemming from adverse life experiences. Perm J. 2014 Winter;18(1):71-7. doi: 10.7812/TPP/13-098. PMID: 24626074; PMCID: PMC3951033.
32. Courtney L, Crawford C, Hickey A (2014) Active Self-CareTherapiesforPain (PACT) WorkingGroup. Mind–Body Therapiesforthe Self-Management of ChronicPainSymptoms. PainMedicine 15: S21–S39. WileyPeriodicals, IncJulienne E. Bower, Michael R. Irwin,Mind–body therapies and control of inflammatory biology: A descriptive review,Brain, Behavior, and Immunity,Volume 51,2016,Pages 1-11,ISSN 0889-1591,https://doi.org/10.1016/j.bbi.2015.06.012. (https://www.sciencedirect.com/science/article/pii/S0889159115001658)
33. Manglani HR, Healy BC, Vranceanu AM. (2022).Demand with low supply: A pipeline for personalized integrative medicine in multiple sclerosis. Mult Scler Relat Disord. 2022 Feb;58:103493. doi: 10.1016/j.msard.2022.103493. Epub 2022 Jan 4. PMID: 35030367.
34. Asadi-Pooya AA, Homayoun M, Sharifi S. Complementary and integrative medicine in epilepsy: What patients and physicians perceive. Epilepsy Behav. 2019 Dec;101(Pt A):106545. doi: 10.1016/j.yebeh.2019.106545. Epub 2019 Nov 6. PMID: 31704582.
35. Kathryn A. Salvati, Mark P. Beenhakker. (2019).Out of thin air: Hyperventilation-triggered seizures,Brain Research,Volume 1703,2019,Pages 41-52, ISSN 0006-8993, <https://doi.org/10.1016/j.brainres.2017.12.037>. (https://www.sciencedirect.com/science/article/pii/S0006899317305796)
36. Kiran Shete, Shraddha Potdar. (2024).Integrative medicine for musculoskeletal pains - A proposed model based on clinical experience,Journal of Ayurveda and Integrative Medicine,Volume 15, Issue 1,2024,100858, ISSN 0975-9476, <https://doi.org/10.1016/j.jaim.2023.100858.(https://www.sciencedirect.com/science/article/pii/S0975947623001754)>
37. Cavezzi A, Ambrosini L, Colucci R, Ionna GD, Urso SU. (2020).Aging in the Perspective of Integrative Medicine, Psychoneuroendocrineimmunology and Hormesis. Curr Aging Sci. 2020;13(2):82-91. doi: 10.2174/1874609812666191129095417. PMID: 31782371.
38. Wang K, Li K, Zhang P, Ge S, Wen X, Wu Z, Yao X, Jiao B, Sun P, Lv P, Lu L.(2021). Mind-Body Exercises for Non-motor Symptoms of Patients With Parkinson's Disease: A Systematic Review and Meta-Analysis. Front Aging Neurosci. 2021 Dec 3;13:770920. doi: 10.3389/fnagi.2021.770920. PMID: 36226304; PMCID: PMC9549381.
39. Modesto-Lowe V, Farahmand P, Chaplin M, Sarro L.(2015). Does mindfulness meditation improve attention in attention deficit hyperactivity disorder? World J Psychiatry. 2015 Dec 22;5(4):397-403. doi: 10.5498/wjp.v5.i4.397. PMID: 26740931; PMCID: PMC4694553
40. Govindan, Radhakrishnan & Manjula, Munivenkatappa & Anjanappa, Shamala. (2018). Effects of Anger on Brain and Body , Anger Management. 10.13140/RG.2.2.35246.46402.
41. Wager TD, Atlas LY. (2015).The neuroscience of placebo effects: connecting context, learning and health. Nat Rev Neurosci. 2015 Jul;16(7):403-18. doi: 10.1038/nrn3976. PMID: 26087681; PMCID: PMC6013051.
42. Crane, G. (2016). Crane, G. (2016). Harnessing the placebo effect: A new model for mind-body healing mechanisms. International Journal of Transpersonal Studies, 35(1), 39-51.. International Journal of Transpersonal Studies, 35 (1). http://dx.doi.org/10.24972/ijts.2016.35.1.39
43. Zhang, Y., Li, W., Xu, S. *et al.* (2025).Global research trends in mind body therapies: a bibliometric analysis. *J Transl Med* **23**, 365 (2025). <https://doi.org/10.1186/s12967-025-06389-3>
44. Felipe Jain, Eric Lenze, Helen Lavretsky. (2023).Advances in Mind/Body Therapies: Concept, Data and Delivery,The American Journal of Geriatric Psychiatry,Volume 31, Issue 3, Supplement,2023,Pages S13-S14,ISSN 1064-7481,https://doi.org/10.1016/j.jagp.2022.12.292.

(<https://www.sciencedirect.com/science/article/pii/S1064748123001173>)

## David Muehsama,f,∗, Susan Lutgendorfb, Paul J. Millsc, Badri Rickhid, Gaétan Chevaliere, Namuun Batf, Deepak Choprac,g, Blake Gurfeinh . (2017). The embodied mind: A review on functional genomic and neurological correlates of mind-body therapies[Neuroscience & Biobehavioral Reviews](https://www.sciencedirect.com/journal/neuroscience-and-biobehavioral-reviews), [Volume 73](https://www.sciencedirect.com/journal/neuroscience-and-biobehavioral-reviews/vol/73/suppl/C), February 2017, Pages 165-181

1. John A. Astin, PhD, Shauna L. Shapiro, PhD, David M. Eisenberg, MD, and Kelly L. Forys, MA (2003).Mind-Body Medicine: State of the Science, Implications for Practice. J Am Board Fam Pract 2003;16:131–47.
2. John A. Astin, Thomas G. Goddard, and Kelly Forys. (2005). Barrıers To The Integratıon Of Mınd-Body Medıcıne: Perceptıons Of Physıcıans, Resıdents, And Medıcal Students. Explore 2005; 1:278-283. © Elsevier Inc. 2005
3. Maldonado, Carlos. (2019). Quantum Theory And The Socıal Scıences. Revista Colombiana de Fisica. 59E. 34-47. 10.15446/mo.n59E.81645.
4. Atmanspacher, Harald. (2024). "Quantum Approaches to Consciousness", The Stanford Encyclopedia of Philosophy (Summer 2024 Edition), Edward N. Zalta & Uri Nodelman (eds.), URL = <https://plato.stanford.edu/archives/sum2024/entries/qt-consciousness/>.
5. Popescu, S. (2014).Nonlocality beyond quantum mechanics. *Nature Phys* **10**, 264–270 (2014). https://doi.org/10.1038/nphys2916
6. Rocha Cabrero F, De Jesus O. Prosopagnosia. [Updated 2023 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK559324/>
7. Bernstein, Michal, and Galit Yovel. (2015). "Two neural pathways of face processing: A critical evaluation of current models." *Neuroscience & Biobehavioral Reviews* 55 (2015): 536-546.
8. Albonico, Andrea, and Jason Barton. (2019). "Progress in perceptual research: the case of prosopagnosia." *F1000Research* 8
9. Wong, Bertrand. (2019). On quantum entanglement. International Journal of Automatic Control System Vol. 5: Issue 2. [www.journalspub.com](http://www.journalspub.com)
10. Singh N, (2022). Spatiotemporal Patterns in Neurobiology: AnOverviewforFutureArtificial Intelligence. PsyArXiv; 306 2022.psyarxiv.com/cpmre,doi:10.31234/osf.io/cpmre
11. Wolfgang Klimesch (2018). The frequency architecture of brain and brain body oscillations: an analysis European Journal of Neuroscience, Vol. 48, pp. 2431–2453,

1. [Heidi L.Helgeson ,](https://www.sciencedirect.com/science/article/pii/S1550830716301124" \l "!) [Colleen Kraft Peyerl ,](https://www.sciencedirect.com/science/article/pii/S1550830716301124" \l "!)[MaritSolheim-Witt](https://www.sciencedirect.com/science/article/pii/S1550830716301124" \l "!) . (2016). Quantum Physics Principles and Communication in the Acute Healthcare Setting: A Pilot Study . [Explore](https://www.sciencedirect.com/science/journal/15508307). [Volume 12, Issue 6](https://www.sciencedirect.com/science/journal/15508307/12/6), November–December 2016, Pages 408-415
2. M. Ekaterina, G. Brida, M. Gramegna, V. Giovannetti, L. Maccone, M. Genovese. (2014). “Time from Quantum Entanglement: An Experimental Illustration.” Phys. Rev. A 89(5), arxiv.org/abs/1310.4691, October 2013
3. Aydore S, Pantazis D, Leahy RM. (2013).A note on the phase locking value and its properties. Neuroimage. 2013 Jul 1;74:231-44. doi: 10.1016/j.neuroimage.2013.02.008. Epub 2013 Feb 19. PMID: 23435210; PMCID: PMC3674231.
4. Eric Verschooten, Shihab Shamma, Andrew J. Oxenham, Brian C.J. Moore, Philip X. Joris, Michael G. Heinz, Christopher J. Plack, (2019).The upper frequency limit for the use of phase locking to code temporal fine structure in humans: A compilation of viewpoints, Hearing Research,Volume 377,2019,Pages 109-121,ISSN 0378-5955, <https://doi.org/10.1016/j.heares.2019.03.011>. (https://www.sciencedirect.com/science/article/pii/S0378595518305604)
5. Reyner-Parra D, Huguet G (2022) Phase-locking patterns underlying effective communication in exact firing rate models of neural networks. PLoS Comput Biol 18(5): e1009342. https://doi.org/10.1371/journal.pcbi.1009342
6. Naresh Satyan, Arseny Vasilyev, George Rakuljic, Jeffrey O. (2012). White, and Amnon Yariv, "Phase-locking and coherent power combining of broadband linearly chirped optical waves," Opt. Express 20, 25213-25227
7. Lepage, Kyle & Vijayan, Sujith. (2017). The Relationship between Coherence and the Phase-Locking Value. Journal of Theoretical Biology. 435. 10.1016/j.jtbi.2017.08.029.
8. Lowet E, Roberts MJ, Bonizzi P, Karel J, De Weerd P (2016) Quantifying Neural Oscillatory Synchronization: A Comparison between Spectral Coherence and Phase-Locking Value Approaches. PLoS ONE 11(1): e0146443. https://doi.org/10.1371/journal.pone.0146443
9. Jacobs J, Kahana MJ, Ekstrom AD, Fried I. (2007).Brain oscillations control timing of single-neuron activity in humans. J Neurosci. 2007 Apr 4;27(14):3839-44. doi: 10.1523/JNEUROSCI.4636-06.2007. PMID: 17409248; PMCID: PMC6672400.
10. H. Nagashino, K. Kawamoto, Y. Kinouchi. (2002).Phase-locked oscillations in a neuronal network model,Neurocomputing,Volumes 44–46,2002,Pages 555-560,ISSN 0925-2312,https://doi.org/10.1016/S0925-2312(02)00423-X. (https://www.sciencedirect.com/science/article/pii/S092523120200423X)
11. Babiloni C, Babiloni F, Carducci F, Cincotti F, Rosciarelli F, Arendt-Nielsen L, Chen AC, Rossini PM. (2002).Human brain oscillatory activity phase-locked to painful electrical stimulations: a multi-channel EEG study. Hum Brain Mapp. 2002 Feb;15(2):112-23. doi: 10.1002/hbm.10013. PMID: 11835602; PMCID: PMC6872083.
12. Yuan Yi , Pang Na , Chen Yudong , Wang Yi , Li Xiaoli A Phase-Locking Analysis of Neuronal Firing Rhythms with Transcranial Magneto-Acoustical Stimulation Based on the Hodgkin-Huxley Neuron Model Frontiers in Computational Neuroscience Volume 11 – 2017 URL=https://www.frontiersin.org/journals/computationalneuroscience/articles/10.3389/fncom.2017.00001 DOI=10.3389/fncom.2017.00001 ISSN=1662-5188
13. Daniel R Schonhaut,Aditya M Rao,Ashwin G Ramayya,Ethan A Solomon, Nora A Herweg, Itzhak Fried, Michael J Kahana (2024)  MTL neurons phase-lock to human hippocampal theta *eLife* 13:e85753., https://doi.org/10.7554/eLife.85753
14. Guillem, K., Ahmed, S.H. (2020).Reorganization of theta phase-locking in the orbitofrontal cortex drives cocaine choice under the influence. *Sci Rep* **10**, 8041 (2020). https://doi.org/10.1038/s41598-020-64962-w
15. Whittington MA, Traub RD, Adams NE. (2019). A future for neuronal oscillation research. Brain Neurosci Adv. 2019 Mar 1;2:2398212818794827. doi: 10.1177/2398212818794827. PMID: 32166146; PMCID: PMC7058255.
16. Mozhgan Khanjanianpak, Nahid Azimi-Tafreshi, Alireza Valizadeh. (2024).Emergence of complex oscillatory dynamics in the neuronal networks with long activity time of inhibitory synapses,iScience,Volume 27, Issue 4,2024,109401,ISSN 2589-0042, <https://doi.org/10.1016/j.isci.2024.109401>.(https://www.sciencedirect.com/science/article/pii/S2589004224006229)
17. Xu, Y., Jia, Y., Ma, J. *et al.* (2018). Collective responses in electrical activities of neurons under field coupling. *Sci Rep* 8, 1349 (2018). https://doi.org/10.1038/s41598-018-19858-1
18. Başar E. (2013). Brain oscillations in neuropsychiatric disease. Dialogues Clin Neurosci. 2013 Sep;15(3):291-300. doi: 10.31887/DCNS.2013.15.3/ebasar. PMID: 24174901; PMCID: PMC3811101.
19. Klein, A., S. S. Ghosh, F. S. Bao, J. Giard, Y. Häme, E. Stavsky, N. Lee, et al. (2017). “Mindboggling morphometry of human brains.” PLoS Computational Biology 13 (2): e1005350. doi:10.1371/journal.pcbi.1005350. http://dx.doi.org/10.1371/journal.pcbi.1005350.
20. Barma, Muntasir And Ramaswamy, Sriram (2000) "Steady States of Dynamically Coupled Two-Species Systems," Turkish Journal of Physics: Vol. 24: No. 3, Article 7. Available at: https://journals.tubitak.gov.tr/physics/vol24/iss3/7
21. Mariscal MG, Levin AR, Gabard-Durnam LJ, Xie W, Tager-Flusberg H, Nelson CA. (2021). EEG Phase-Amplitude Coupling Strength and Phase Preference: Association with Age over the First Three Years after Birth. eNeuro. 2021 Jun 24;8(3):ENEURO.0264-20.2021. doi: 10.1523/ENEURO.0264-20.2021. PMID: 34049989; PMCID: PMC8225408.
22. Belluscio MA, Mizuseki K, Schmidt R, Kempter R, Buzsáki G. (2012).Cross-frequency phase-phase coupling between θ and γ oscillations in the hippocampus. J Neurosci. 2012 Jan 11;32(2):423-35. doi: 10.1523/JNEUROSCI.4122-11.2012. PMID: 22238079; PMCID: PMC3293373.
23. Parham Mostame, Sepideh Sadaghiani. (2020). Phase- and amplitude-coupling are tied by an intrinsic spatial organization but show divergent stimulus-related changes,NeuroImage, Volume 219, 2020, 117051, ISSN 1053 8119, https://doi.org/10.1016/j.neuroimage.2020.117051.(https://www.sciencedirect.com/science/article/pii/S1053811920305371)
24. Hülsemann Mareike J., Naumann Ewald, Rasch Björn. (2019). Quantification of Phase-Amplitude Coupling in Neuronal Oscillations: Comparison of Phase-Locking Value, Mean Vector Length, Modulation Index, and Generalized-Linear-Modeling-Cross-Frequency-Coupling. Frontiers in Neuroscience. Volume 13 – 2019 URL=https://www.frontiersin.org/journals/neuroscience/articles/10.3389/fnins.2019.00573DOI=10.3389/fnins.2019.00573 ISSN=1662-453X
25. Munia, T.T.K., Aviyente, S. (2019).Time-Frequency Based Phase-Amplitude Coupling Measure For Neuronal Oscillations. *Sci Rep* **9**, 12441 (2019). https://doi.org/10.1038/s41598-019-48870-2
26. David Baur, Maria Ermolova, Victor Hugo Souza, Christoph Zrenner, Ulf Ziemann. (2022).,Phase-amplitude coupling in high-gamma frequency range induces LTP-like plasticity in human motor cortex: EEG-TMS evidence,Brain Stimulation,Volume 15, Issue 6,2022,Pages 1508-1510,ISSN 1935-861X,https://doi.org/10.1016/j.brs.2022.11.003. (https://www.sciencedirect.com/science/article/pii/S1935861X22002376)
27. Nayak CS, Anilkumar AC. [Updated 2023 Jul 24]. EEG Normal Waveforms. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK539805/
28. Newson Jennifer J. , Thiagarajan Tara C. (2019). EEG Frequency Bands in Psychiatric Disorders: A Review of Resting State Studies. Frontiers in Human Neuroscience. Volume 12 – 2018,2019 URL=https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2018.00521 DOI=10.3389/fnhum.2018.00521 ISSN=1662-5161
29. Saby JN, Marshall PJ.(2012). The utility of EEG band power analysis in the study of infancy and early childhood. Dev Neuropsychol. 2012;37(3):253-73. doi: 10.1080/87565641.2011.614663. PMID: 22545661; PMCID: PMC3347767.
30. Czeszumski Artur, Eustergerling Sara, Lang Anne, Menrath David, Gerstenberger Michael , Schuberth Susanne , Schreiber Felix , Rendon Zadkiel Zuluaga , König Peter. (2020). Hyperscanning: A Valid Method to Study Neural Inter-brain Underpinnings of Social Interaction.Frontiers in Human Neuroscience.Volume 14 – 2020. 2020 URL=https://www.frontiersin.org/journals/humanneuroscience/articles/10.3389/fnhum.2020.00039. DOI=10.3389/fnhum.2020.00039 ISSN=1662-5161
31. Zamm A, Loehr JD, Vesper C, Konvalinka I, Kappel SL, Heggli OA, Vuust P, Keller PE. (2024). A practical guide to EEG hyperscanning in joint action research: from motivation to implementation. Soc Cogn Affect Neurosci. 2024 May 10;19(1):nsae026. doi: 10.1093/scan/nsae026. PMID: 38584414; PMCID: PMC11086947.
32. Short, M.R., Hernandez-Pavon, J.C., Jones, A. *et al.*  (2021).EEG hyperscanning in motor rehabilitation: a position paper. *J NeuroEngineering Rehabil* **18**, 98 (2021). https://doi.org/10.1186/s12984-021-00892-6
33. Marius Zimmermann, Kathrine Schultz-Nielsen, Guillaume Dumas, Ivana Konvalinka. (2024). Arbitrary methodological decisions skew inter-brain synchronization estimates in hyperscanning-EEG studies. *Imaging Neuroscience* 2024; 2 1–19. doi: <https://doi.org/10.1162/imag_a_00350>
34. N. Sinha, T. Maszczyk, Zhang Wanxuan, J. Tan and J. Dauwels. (2016). "EEG hyperscanning study of inter-brain synchrony during cooperative and competitive interaction," 2016 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Budapest, Hungary, 2016, pp. 004813-004818, doi: 10.1109/SMC.2016.7844990.
35. Balconi M, Angioletti L, Cassioli F. (2023).Hyperscanning EEG Paradigm Applied to Remote vs. Face-To-Face Learning in Managerial Contexts: Which Is Better? Brain Sci. 2023 Feb 18;13(2):356. doi: 10.3390/brainsci13020356. PMID: 36831899; PMCID: PMC9954592.
36. Liu Difei , Liu Shen , Liu Xiaoming , Zhang Chong , Li Aosika , Jin Chenggong , Chen Yijun , Wang Hangwei , Zhang Xiaochu . (2018).Interactive Brain Activity: Review and Progress on EEG-Based Hyperscanning in Social Interactions. Frontiers in Psychology. Volume 9 – 2018 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.01862

DOI=10.3389/fpsyg.2018.01862. ISSN=1664-1078

1. Takahiko Koike, Hiroki C. Tanabe, Norihiro Sadato. (2015). Hyperscanning neuroimaging technique to reveal the “two-in-one” system in social interactions,Neuroscience Research,Volume 90,2015,Pages 25-32,ISSN 0168-0102, <https://doi.org/10.1016/j.neures.2014.11.006>.(https://www.sciencedirect.com/science/article/pii/S0168010214002958)
2. Silke Anders, Julius Verrel, John-Dylan Haynes, Thomas Ethofer (2016).Pseudo-hyperscanning shows common neural activity during face-to-face communication of affect to be associated with shared affective feelings but not with mere emotion recognition,Cortex, Volume 131, 2020, Pages 210-220, ISSN 0010-9452, <https://doi.org/10.1016/j.cortex.2020.06.015.n> (https://www.sciencedirect.com/science/article/pii/S0010945220302793)
3. Alejandro Pérez, Philip J. Monahan, Matthew A. Lambon Ralph. (2021).Joint recording of EEG and audio signals in hyperscanning and pseudo-hyperscanning experiments,MethodsX, Volume 8,2021,101347, ISSN 2215-0161,https://doi.org/10.1016/j.mex.2021.101347. (https://www.sciencedirect.com/science/article/pii/S2215016121001400)
4. Liu Difei , Liu Shen , Liu Xiaoming , Zhang Chong , Li Aosika , Jin Chenggong , Chen Yijun , Wang Hangwei , Zhang Xiaochu . (2018). Interactive Brain Activity: Review and Progress on EEG-Based Hyperscanning in Social Interactions. Frontiers in Psychology. Volume 9 – 2018 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.01862 DOI=10.3389/fpsyg.2018.01862 ISSN=1664-1078
5. Nicolina Sciaraffa, Jieqiong Liu, Pietro Aricò, Gianluca Di Flumeri, Bianca M S Inguscio, Gianluca Borghini, Fabio Babiloni. (2021).Multivariate model for cooperation: bridging social physiological compliance and hyperscanning, *Social Cognitive and Affective Neuroscience*, Volume 16, Issue 1-2, January-February 2021, Pages 193–209. <https://doi.org/10.1093/scan/nsaa119>
6. Shaffer Fred, Meehan Zachary M.(2020). A Practical Guide to Resonance Frequency Assessment for Heart Rate Variability Biofeedback.Frontiers in Neuroscience.Volume 14 – 2020 URL=https://www.frontiersin.org/journals/neuroscience/articles/10.3389/fnins.2020.570400. DOI=10.3389/fnins.2020.570400. ISSN=1662-453X
7. Jozwiak M, Teboul JL. (2024). Heart-Lungs interactions: the basics and clinical implications. Ann Intensive Care. 2024 Aug 12;14(1):122. doi: 10.1186/s13613-024-01356-5. PMID: 39133379; PMCID: PMC11319696.
8. Elie Rassi, Georg Dorffner, Walter Gruber, Manuel Schabus, Wolfgang Klimesch. (2019). Coupling and Decoupling between Brain and Body Oscillations, Neuroscience Letters, Volume 711, 2019, 134401, ISSN 0304-3940, <https://doi.org/10.1016/j.neulet.2019.134401>. (<https://www.sciencedirect.com/science/article/pii/S030439401930504X>)
9. Bourguignon, M., Jousmäki, V., Dalal, S. S., Jerbi, K., & De Tiège, X. (2019). Coupling between human brain activity and body movements: Insights from non-invasive electromagnetic recordings. NeuroImage, 203, Article 116177. <https://doi.org/10.1016/j.neuroimage.2019.116177>
10. Criscuolo, A., Schwartze, M., & Kotz, S. A. (2022). Cognition through the lens of a body-brain dynamic system. Trends in Neurosciences, 45(9), 667-677. <https://doi.org/10.1016/j.tins.2022.06.004>
11. Bolt T, Wang S, Nomi JS, Setton R, Gold BP, Frederick BD, Yeo BTT, Chen JJ, Picchioni D, Spreng RN, Keilholz SD, Uddin LQ, Chang C. (2024).Widespread Autonomic Physiological Coupling Across the Brain-Body Axis. bioRxiv [Preprint]. 2024 Jul 29:2023.01.19.524818. doi: 10.1101/2023.01.19.524818. PMID: 39131291; PMCID: PMC11312447.
12. Cebolla Ana Maria , Cheron Guy. (2019). Understanding Neural Oscillations in the Human Brain: From Movement to Consciousness and Vice Versa.Frontiers in Psycholog.Volume 10 – 2019.URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2019.01930 DOI=10.3389/fpsyg.2019.01930. ISSN=1664-1078
13. Jee S.(2021). Brain Oscillations and Their Implications for Neurorehabilitation. Brain Neurorehabil. 2021 Mar 23;14(1):e7. doi: 10.12786/bn.2021.14.e7. PMID: 36742108; PMCID: PMC9879411.
14. Beste, C. (2023). Münchau, A. & Frings, C. Towards a systematization of brain oscillatory activity in actions. *Commun Biol* **6**, 137 .https://doi.org/10.1038/s42003-023-04531-9
15. Li, T., Zheng, Y., Wang, Z. *et al. (2022).* Brain information processing capacity modeling. *Sci Rep* **12**, 2174 (2022). <https://doi.org/10.1038/s41598-022-05870-z>
16. Chalk, Matthew & Herrero, Jose & Gieselmann, Marc & Delicato, Louise & Gotthardt, Sascha & Thiele, Alexander. (2010). Attention Reduces Stimulus-Driven Gamma Frequency Oscillations and Spike Field Coherence in V1. Neuron. 66. 114-25. 10.1016/j.neuron.2010.03.013.
17. Jiajia Li, Xuan Zhang, Mengmeng Du, Ying Wu (2022).Switching behavior of the gamma power in the neuronal network modulated by the astrocytes,Chaos, Solitons & Fractals,Volume 159, 2022, 112135, ISSN 0960-0779, <https://doi.org/10.1016/j.chaos.2022.112135>.
18. Yoritaka Akimoto, Takayuki Nozawa, Akitake Kanno, Mizuki Ihara, Takakuni Goto, Takeshi Ogawa, Toshimune Kambara, Motoaki Sugiura, Eiichi Okumura, Ryuta Kawashima. (2014). High-gamma activity in an attention network predicts individual differences in elderly adults' behavioral performance. NeuroImage,Volume 100,Pages 290-300, ISSN 1053-8119, <https://doi.org/10.1016/j.neuroimage.2014.06.037>. (https://www.sciencedirect.com/science/article/pii/S105381191400514X)
19. Zheng Tianyi , Sugino Masato , Jimbo Yasuhiko , Ermentrout G. Bard , Kotani Kiyoshi. (2024). Analyzing top-down visual attention in the context of gamma oscillations: a layer- dependent network-of- networks approach. Frontiers in Computational Neuroscience.Volume 18 – 2024 URL=https://www.frontiersin.org/journals/computationalneuroscience/articles/10.3389/fncom.2024.1439632. DOI=10.3389/fncom.2024.1439632. ISSN=1662-5188
20. Bryant AS, Goddard CA, Huguenard JR, Knudsen EI. (2015).Cholinergic control of gamma power in the midbrain spatial attention network. J Neurosci. 2015 Jan 14;35(2):761-75. doi: 10.1523/JNEUROSCI.4001-14.2015. PMID: 25589769; PMCID: PMC4293421.
21. Goddard CA, Sridharan D, Huguenard JR, Knudsen EI.(2012). Gamma oscillations are generated locally in an attention-related midbrain network. Neuron. 2012 Feb 9;73(3):567-80. doi: 10.1016/j.neuron.2011.11.028. PMID: 22325207; PMCID: PMC3291715.
22. Ishii Ryouhei , Canuet Leonides , Ishihara Tsutomu , Aoki Yasunori , Ikeda Shunichiro , Hata Masahiro , Katsimichas Themistoklis , Gunji Atsuko , Takahashi Hidetoshi , Nakahachi Takayuki , Iwase Masao , Takeda Masatoshi. (2014).Frontal midline theta rhythm and gamma power changes during focused attention on mental calculation: an MEG beamformer analysis. Frontiers in Human Neuroscience.Volume 8 – 2014 URL=https://www.frontiersin.org/journals/humanneuroscience/articles/10.3389/fnhum.2014.00406 . DOI=10.3389/fnhum.2014.00406. ISSN=1662-5161
23. Seguin, C., Sporns, O. & Zalesky, A. Brain network communication: concepts, models and applications. *Nat. Rev. Neurosci.* **24**, 557–574 (2023). <https://doi.org/10.1038/s41583-023-00718-5>
24. Mathilde Bonnefond, Sabine Kastner, Ole Jensen. (2017).Communication between brain areas based on nested oscillations. E Neuro 10 March 2017, 4(2). ENeuro. 0153-16.2017; Doi: 10.1523/ENEURO.0153-16.2017
25. Griffa, A., Mach, M., Dedelley, J. *et al.* (2023).Evidence for increased parallel information transmission in human brain networks compared to macaques and male mice. *Nat Commun* 14, 8216 (2023). <https://doi.org/10.1038/s41467-023-43971-z>
26. Kohn A, Jasper AI, Semedo JD, Gokcen E, Machens CK, Yu BM. (2020).Principles of Corticocortical Communication: Proposed Schemes and Design Considerations. Trends Neurosci. 2020 Sep;43(9):725-737. doi: 10.1016/j.tins.2020.07.001. Epub 2020 Aug 5. PMID: 32771224; PMCID: PMC7484382.
27. Chapeton JI, Haque R, Wittig JH Jr, Inati SK, Zaghloul KA.(2019). Large-Scale Communication in the Human Brain Is Rhythmically Modulated through Alpha Coherence. Curr Biol. 2019 Sep 9;29(17):2801-2811.e5. doi: 10.1016/j.cub.2019.07.014. Epub 2019 Aug 15. PMID: 31422882; PMCID: PMC6736747.
28. Miroschnikow A, Schlegel P, Schoofs A, Hueckesfeld S, Li F, Schneider-Mizell CM, Fetter RD, Truman JW, Cardona A, Pankratz MJ.(2018). Convergence of monosynaptic and polysynaptic sensory paths onto common motor outputs in a *Drosophila* feeding connectome. Elife. 2018 Dec 11;7:e40247. doi: 10.7554/eLife.40247. PMID: 30526854; PMCID: PMC6289573.
29. Wang Z, Yang Y, Huang Z, Zhao W, Su K, Zhu H, et al. (2025) Exploring the transmission of cognitive task information through optimal brain pathways. PLoS Comput Biol 21(3): e1012870. https://doi.org/10.1371/journal.pcbi.1012870
30. Liu Xiaotong , Han Fang , Fu Rui , Wang Qingyun , Luan Guoming Epileptogenic Zone Location of Temporal Lobe Epilepsy by Cross-Frequency Coupling Analysis Frontiers in Neurology Volume12–2021 URL=https://www.frontiersin.org/journals/neurology/articles/10.3389/fneur.2021.764821 DOI=10.3389/fneur.2021.764821 ISSN=1664-2295
31. *Jeffrey R. Tenney, Brady J. Williamson, and Darren S. Kadis. (2022).* [Cross-Frequency Coupling in Childhood Absence Epilepsy](https://www.liebertpub.com/doi/abs/10.1089/brain.2021.0119). Brain Connectivity 2022 12:5, 489-496
32. *Li Chunsheng , Liu Shiyue , Wang Zeyu , Yuan Guanqian. (2023). Classifying epileptic phase-amplitude coupling in SEEG using complex-valued convolutional neural network Frontiers in PhysiologyVolume13–2022n URL=https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2022.1085530 DOI=10.3389/fphys.2022.1085530 ISSN=1664-042X*,
33. Chien-Hung Yeh, Chuting Zhang, Wenbin Shi, Men-Tzung Lo, Gerd Tinkhauser Ashwini Oswal. (2023). Cross-Frequency Coupling and Intelligent Neuromodulation.*Cyborg Bionic Syst.*2023;4:0034.DOI:[10.34133/cbsystems.0034](https://doi.org/10.34133/cbsystems.0034)
34. Canolty RT, Knight RT.(2010).The functional role of cross-frequency coupling. Trends Cogn Sci. 2010 Nov;14(11):506-15. doi: 10.1016/j.tics.2010.09.001. PMID: 20932795; PMCID: PMC3359652.
35. Scheffer-Teixeira, R., Tort, A.B.L. (2018). Theta-Gamma Cross-Frequency Analyses (Hippocampus). In: Jaeger, D., Jung, R. (eds) Encyclopedia of Computational Neuroscience. Springer, New York, NY. <https://doi.org/10.1007/978-1-4614-7320-6_100658-1>
36. Jirsa Viktor, Müller Viktor. (2013). Cross-frequency coupling in real and virtual brain. Frontiers in Computational Neuroscience networks Volume7-2013 URL=https://www.frontiersin.org/journals/computational-neuroscience/articles/10.3389/fncom.2013.00078 DOI=10.3389/fncom.2013.00078 ISSN=1662-5188
37. Patel AK, Reddy V, Shumway KR, et al.(2025). Physiology, Sleep Stages. [Updated 2024 Jan 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK526132/>
38. Criscuolo, A., Schwartze, M., & Kotz, S. A. (2022). Cognition through the lens of a body-brain dynamic system. Trends in Neurosciences, 45(9), 667-677. <https://doi.org/10.1016/j.tins.2022.06.004>
39. Gu, S., Cieslak, M., Baird, B. *et al.* (2018). The Energy Landscape of Neurophysiological Activity Implicit in Brain Network Structure. *Sci Rep* **8**, 2507 <https://doi.org/10.1038/s41598-018-20123-8>
40. Vozzi, A., Martinez Levy, A., Ronca, V., Giorgi, A., Ferrara, S., Mancini, M., Capotorto, R., Cherubino, P., Trettel, A., Babiloni, F., & Di Flumeri, G. (2023). Time-Dependent Analysis of Human Neurophysiological Activities during an Ecological Olfactory Experience. Brain Sciences, 13(9), 1242. <https://doi.org/10.3390/brainsci13091242>
41. Buzsáki G, Watson BO. Brain rhythms and neural syntax: implications for efficient coding of cognitive content and neuropsychiatric disease. Dialogues Clin Neurosci. 2012 Dec;14(4):345-67. doi: 10.31887/DCNS.2012.14.4/gbuzsaki. PMID: 23393413; PMCID: PMC3553572.
42. Jacob LPL, Bailes SM, Williams SD, Stringer C, Lewis LD. (2024). Brainwide hemodynamics predict neural rhythms across sleep and wakefulness in humans. bioRxiv [Preprint]. 2024 Nov 17:2024.01.29.577429. doi: 10.1101/2024.01.29.577429. PMID: 38352426; PMCID: PMC10862763.
43. Chandravadia, Nand & Imam, Nabil. (2025). Neural rhythms as priors of speech computations. 10.1101/2025.05.06.652542.
44. van Bree S, Sohoglu E, Davis MH, Zoefel B (2021) Sustained neural rhythms reveal endogenous oscillations supporting speech perception. PLoS Biol 19(2): e3001142. <https://doi.org/10.1371/journal.pbio.3001142>
45. Buzsáki G, WangX-J. (2012).Mechanisms of γ oscillations. *Ann Rev Neurosci.* 2012;35:203-225.
46. Fries P. Rhythms for Cognition: Communication through Coherence. Neuron. 2015 Oct 7;88(1):220-35. doi: 10.1016/j.neuron.2015.09.034. PMID: 26447583; PMCID: PMC4605134.
47. Akam TE, Kullmann DM (2012) Efficient “Communication through Coherence” Requires Oscillations Structured to Minimize Interference between Signals. PLoS Comput Biol 8(11): e1002760. https://doi.org/10.1371/journal.pcbi.1002760
48. Andre M Bastos, Julien Vezoli, Pascal Fries (2022)., Communication through coherence with inter-areal delays, Current Opinion in Neurobiology, Volume 31, 2015, Pages 173-180, ISSN 0959-4388, https://doi.org/10.1016/j.conb.2014.11.001. (https://www.sciencedirect.com/science/article/pii/S0959438814002165)
49. Yamazaki K, Vo-Ho VK, Bulsara D, Le N.(2022). Spiking Neural Networks and Their Applications: A Review. Brain Sci. 2022 Jun 30;12(7):863. doi: 10.3390/brainsci12070863. PMID: 35884670; PMCID: PMC9313413.
50. Stanojevic, A., Woźniak, S., Bellec, G. *et al.* High-performance deep spiking neural networks with 0.3 spikes per neuron. *Nat Commun* **15**, 6793 (2024). <https://doi.org/10.1038/s41467-024-51110-5>
51. Samanwoy Ghosh-Dastıdar and Hojjat Adelı. (2009). [Spıkıng Neural Networks](https://www.worldscientific.com/doi/abs/10.1142/S0129065709002002) International Journal of Neural Systems 2009 19:04, 295-308
52. G. Shen, D. Zhao, Y. Dong, & Y. Zeng, (2023). Brain-inspired neural circuit evolution for spiking neural networks, *Proc. Natl. Acad. Sci. U.S.A.* 120 (39) e2218173120, <https://doi.org/10.1073/pnas.2218173120>
53. Sebastian Idesis, Michele Allegra, Jakub Vohryzek, Yonatan Sanz Perl, Nicholas V Metcalf, Joseph C Griffis, Maurizio Corbetta, Gordon L Shulman, Gustavo Deco, (2024).Generative whole-brain dynamics models from healthy subjects predict functional alterations in stroke at the level of individual patients, *Brain Communications*, Volume 6, Issue 4, 2024, fcae237, <https://doi.org/10.1093/braincomms/fcae237>
54. Geli, Sebastian & Lynn, Christopher & Kringelbach, Morten & Deco, Gustavo & Perl, Yonatan. (2025). Non-equilibrium whole-brain dynamics arise from pairwise interactions. Cell Reports Physical Science. 6. 102464. 10.1016/j.xcrp.2025.102464.
55. Standage DI, Areshenkoff CN, Gale DJ, Nashed JY, Flanagan JR, Gallivan JP.(2023). Whole-brain dynamics of human sensorimotor adaptation. Cereb Cortex. 2023 Apr 4;33(8):4761-4778. doi: 10.1093/cercor/bhac378. PMID: 36245212; PMCID: PMC10110437.
56. Hamilton, Leah K., "A Model" (2011). Electronic Thesis and Dissertation Repository. 222. https://ir.lib.uwo.ca/etd/222
57. Helfrich RF, Knight RT.(2016). Oscillatory Dynamics of Prefrontal Cognitive Control. Trends Cogn Sci. 2016 Dec;20(12):916-930. doi: 10.1016/j.tics.2016.09.007. Epub 2016 Oct 12. PMID: 27743685; PMCID: PMC5127407.
58. Ulloa José Luis . (2022).The Control of Movements via Motor Gamma Oscillations Frontiers in Human Neuroscience Volume 15 – 2021. URL=https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2021.787157 DOI=10.3389/fnhum.2021.787157 ISSN=1662-5161
59. Hebb AO, Zhang JJ, Mahoor MH, Tsiokos C, Matlack C, Chizeck HJ, Pouratian N. (2014).Creating the feedback loop: closed-loop neurostimulation. Neurosurg Clin N Am. 2014 Jan;25(1):187-204. doi: 10.1016/j.nec.2013.08.006. Epub 2013 Oct 23. PMID: 24262909; PMCID: PMC4058859.
60. Pei, A., & Shinn-Cunningham, B. G. (2023). Closed-Loop Current Stimulation Feedback Control of a Neural Mass Model Using Reservoir Computing. Applied Sciences, 13(3), 1279. <https://doi.org/10.3390/app13031279>
61. Bordoni B, Purgol S, Bizzarri A, Modica M, Morabito B.(2018). The Influence of Breathing on the Central Nervous System. Cureus. 2018 Jun 1;10(6):e2724. doi: 10.7759/cureus.2724. PMID: 30083485; PMCID: PMC6070065.
62. Brinkman JE, Toro F, Sharma S. [Updated 2023 Jun 5]. Physiology, Respiratory Drive. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482414/
63. HJ Moutlan. (2020). Physiological control of respiration Southern African Journal of Anaesthesia and Analgesia. 2020;26(6 Suppl 3):S128-132
64. Phillips AA, Chan FH, Zheng MM, Krassioukov AV, Ainslie PN.(2016). Neurovascular coupling in humans: Physiology, methodological advances and clinical implications. J Cereb Blood Flow Metab. 2016 Apr;36(4):647-64. doi: 10.1177/0271678X15617954. Epub 2015 Nov 24. PMID: 26661243; PMCID: PMC4821024
65. Iadecola C. (2017).The Neurovascular Unit Coming of Age: A Journey through Neurovascular Coupling in Health and Disease. Neuron. 2017 Sep 27;96(1):17-42. doi: 10.1016/j.neuron.2017.07.030. PMID: 28957666; PMCID: PMC5657612.
66. Kaplan, L., Chow, B.W. & Gu, C. (2020).Neuronal regulation of the blood–brain barrier and neurovascular coupling. *Nat Rev Neurosci* 21, 416–432 (2020). <https://doi.org/10.1038/s41583-020-0322-2>
67. Stackhouse Teresa L.,Mishra Anusha. (2021). Neurovascular Coupling in Development and Disease: Focus on Astrocytes Frontiers in Cell and Developmental Biology Volume 9 - 2021 URL=https://www.frontiersin.org/journals/cell-and-developmental-biology/articles/10.3389/fcell.2021.702832 DOI=10.3389/fcell.2021.702832 ISSN=2296-634X
68. Tournissac, M., Chaigneau, E., Pfister, S. *et al.* (2024).Neurovascular coupling and CO2 interrogate distinct vascular regulations. *Nat Commun* **15**, 7635 (2024). https://doi.org/10.1038/s41467-024-49698-9
69. Pollock JD, Makaryus AN. [Updated 2022 Oct 3]. Physiology, Cardiac Cycle. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK459327/>
70. Nokia MS, Xu W, Wikgren J. (2024).The cardiac cycle modulates learning-related interoception. Trends Cogn Sci. 2024 Aug;28(8):691-692. doi: 10.1016/j.tics.2024.05.007. Epub 2024 May 28. PMID: 38811318.
71. Fouragnan, E.F., Hosking, B., Cheung, Y. *et al.* (2024).Timing along the cardiac cycle modulates neural signals of reward-based learning. *Nat Commun* 15, 2976 (2024). https://doi.org/10.1038/s41467-024-46921-5
72. Nico Adelhöfer, Marie Luise Schreiter, Christian Beste. (2020).Cardiac cycle gated cognitive-emotional control in superior frontal cortices,NeuroImage,Volume 222,2020,117275,ISSN 1053-8119,https://doi.org/10.1016/j.neuroimage.2020.117275. (https://www.sciencedirect.com/science/article/pii/S1053811920307618)
73. McGovern H. T. , Otten Marte. (2024) Priors and prejudice: hierarchical predictive processing in intergroup perception Frontiers in Psychology Volume 15 - 2024 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2024.1386370 DOI=10.3389/fpsyg.2024.1386370 ISSN=1664-1078
74. Caucheteux, C., Gramfort, A. & King, JR. (2023). Evidence of a predictive coding hierarchy in the human brain listening to speech. *Nat Hum Behav* **7**, 430–441 (2023). https://doi.org/10.1038/s41562-022-01516-2
75. Klemm WR.(2011). Neural representations of the sense of self. Adv Cogn Psychol. 2011;7:16-30. doi: 10.2478/v10053-008-0084-2. Epub 2011 Jul 20. PMID: 21826192; PMCID: PMC3163487.
76. Friedemann Pulvermüller (2013).How neurons make meaning: brain mechanisms for embodied and abstract-symbolic semantics, Trends in Cognitive Sciences, Volume 17, Issue 9, 2013, Pages 458-470, ISSN 1364-6613 https://doi.org/10.1016/j.tics.2013.06.004(https://www.sciencedirect.com/science/article/pii/S1364661313001228)
77. E. De Falco,M. Solcà, F. Bernasconi, M. Babo-Rebelo, N. Young, F. Sammartino, C. Tallon-Baudry, V. Navarro,A.R. Rezai, V. Krishna, & O. Blanke . (2024).Single neurons in the thalamus and subthalamic nucleus process cardiac and respiratory signals in humans, *Proc. Natl. Acad. Sci. U.S.A.* 121 (11) e2316365121, <https://doi.org/10.1073/pnas.2316365121>
78. Christopher Caleb Angelakos, Kasey S. Girven, Yin Liu, Oscar C. Gonzalez, Keith R. Murphy, Kim J. Jennings, William J. Giardino, Larry S. Zweifel, Azra Suko, Richard D. Palmiter, Stewart D. Clark, Mark A. Krasnow, Michael R. Bruchas, Luis de Lecea, (2023).A cluster of neuropeptide S neurons regulates breathing and arousal,Current Biology,Volume 33, Issue 24,2023,Pages 5439-5455.e7,ISSN 0960-9822, <https://doi.org/10.1016/j.cub.2023.11.018.(https://www.sciencedirect.com/science/article/pii/S0960982223015324)>
79. Shawn D X Kong, Christopher J Gordon, Camilla M Hoyos, Rick Wassing, Angela D’Rozario, Loren Mowszowski, Catriona Ireland, Jake R Palmer, Ronald R Grunstein, James M Shine, Andrew C McKinnon, Sharon L Naismith (2023). Heart rate variability during slow wave sleep is linked to functional connectivity in the central autonomic network, *Brain Communications*, Volume 5, Issue 3, 2023, fcad129, <https://doi.org/10.1093/braincomms/fcad129>
80. Chouchou Florian , Desseilles Martin . (2014).Heart rate variability: a tool to explore the sleeping brain? Frontiers in Neuroscience Volume 8 - 2014 URL=https://www.frontiersin.org/journals/neuroscience/articles/10.3389/fnins.2014.00402 DOI=10.3389/fnins.2014.00402 ISSN=1662-453X
81. [Silvani Alessandro](https://royalsocietypublishing.org/author/Silvani%2C+Alessandro),[Calandra-Buonaura Giovanna](https://royalsocietypublishing.org/author/Calandra-Buonaura%2C+Giovanna),[Dampney Roger A. L.](https://royalsocietypublishing.org/author/Dampney%2C+Roger+A+L) And [Cortelli Pietro](https://royalsocietypublishing.org/author/Cortelli%2C+Pietro). (2016).Brain–heart interactions: physiology and clinical implications*Phil. Trans. R. Soc. A.***374**20150181[http://doi.org/10.1098/rsta.2015.0181](https://doi.org/10.1098/rsta.2015.0181)
82. Choi, J., Kwon, M., & Jun, S. C. (2020). A Systematic Review of Closed-Loop Feedback Techniques in Sleep Studies—Related Issues and Future Directions. Sensors, 20(10), 2770. <https://doi.org/10.3390/s20102770>
83. Nayak CS, Anilkumar AC. [Updated 2023 Jul 24]. EEG Normal Waveforms. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK539805/
84. Patel AK, Reddy V, Shumway KR, et al. [Updated 2024 Jan 26]. Physiology, Sleep Stages. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK526132/>
85. Pruitt TA, Halpern AR, Pfordresher PQ. (2018). Covert singing in anticipatory auditory imagery. Psychophysiology. 2019 Mar;56(3):e13297. doi: 10.1111/psyp.13297. Epub 2018 Oct 25. PMID: 30368823.
86. Schäfer, T. (2023). The positive effects of online group singing on psycho-physiological variables during the COVID-19 pandemic: A pilot randomized controlled trial. Applied Psychology: Health and Well-Being, 15(4), 1254-1270. https:// doi.org/10.1111/aphw.12435
87. Greenspon, E.B., Montanaro, V. (2023). Singing ability is related to vocal emotion recognition: Evidence for shared sensorimotor processing across speech and music. *Atten Percept Psychophys* **85**, 234–243 <https://doi.org/10.3758/s13414-022-02613-0>
88. Filippa, M., Lima, D., Grandjean, A. *et al.* (2022). Emotional prosody recognition enhances and progressively complexifies from childhood to adolescence. *Sci Rep* 12, 17144<https://doi.org/10.1038/s41598-022-21554-0>
89. Michele Morningstar, Eric E. Nelson, Melanie A. (2018).Dirks,Maturation of vocal emotion recognition: Insights from the developmental and neuroimaging literature,Neuroscience & Biobehavioral Reviews,Volume 90,2018,Pages 221-230,ISSN 0149-7634, <https://doi.org/10.1016/j.neubiorev.2018.04.019.(https://www.sciencedirect.com/science/article/pii/S0149763417306693)>
90. Selosse Garance , Grandjean Didier , Ceravolo Leonardo. (2022). Influence of bodily resonances on emotional prosody perception Frontiers in Psychology Volume 13 - 2022 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.1061930 DOI=10.3389/fpsyg.2022.1061930 ISSN=1664-1078
91. Leipold S, Abrams DA, Karraker S, Menon V. (2023).Neural decoding of emotional prosody in voice-sensitive auditory cortex predicts social communication abilities in children. Cereb Cortex. 2023 Jan 5;33(3):709-728. doi: 10.1093/cercor/bhac095. PMID: 35296892; PMCID: PMC9890475.
92. Park M, Gutyrchik E, Welker L, Carl P, Pöppel E, Zaytseva Y, Meindl T, Blautzik J, Reiser M, Bao Y. (2015).Sadness is unique: neural processing of emotions in speech prosody in musicians and non-musicians. Front Hum Neurosci. 2015 Jan 30;8:1049. doi: 10.3389/fnhum.2014.01049. PMID: 25688196; PMCID: PMC4311618.
93. Konadath S, Raveendran R, Yeshoda K. (2021).Perception of speech stress in children with hearing impairment. Int J Pediatr Otorhinolaryngol. 2021 Jan;140:110495. doi: 10.1016/j.ijporl.2020.110495. Epub 2020 Nov 12. PMID: 33221034.
94. Emma B. Greenspon, Anna M. Gentile, Tim A. Pruitt, Andrea R. Halpern & Peter Q. Pfordresher (2023) Subvocalization during Preparatory and Nonpreparatory Auditory Imagery, Auditory Perception & Cognition, 6:1-2, 108-127, DOI: 10.1080/25742442.2022.2163582
95. Patel AD. (2014). Can nonlinguistic musical training change the way the brain processes speech? The expanded OPERA hypothesis. Hear Res. 2014 Feb;308:98-108. doi: 10.1016/j.heares.2013.08.011. Epub 2013 Sep 20. PMID: 24055761.
96. Konečni VJ (2016) Comprehending Smiles Seldom Requires Embodied Simulation and Felt Emotion. Clin Exp Psychol 2: 114. doi:10.4172/2471- 2701.1000114
97. Orlowska Anna B. , Krumhuber Eva G. , Rychlowska Magdalena , Szarota. (2018). Piotr Dynamics Matter: Recognition of Reward, Affiliative, and Dominance Smiles From Dynamic vs. Static Displays Frontiers in Psychology Volume 9 - 2018 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.00938 DOI=10.3389/fpsyg.2018.00938 ISSN=1664-1078
98. Grossberg, S. (2019).The resonant brain: How attentive conscious seeing regulates action sequences that interact with attentive cognitive learning, recognition, and prediction. *Atten Percept Psychophys* **81**, 2237–2264 (2019). https://doi.org/10.3758/s13414-019-01789-2
99. Klimesch W. (2018).The frequency architecture of brain and brain body oscillations: an analysis. Eur J Neurosci. 2018 Oct;48(7):2431-2453. doi: 10.1111/ejn.14192. PMID: 30281858; PMCID: PMC6668003.
100. Magazù, S., Caccamo, M.T. (2024). Parametric resonance brain model. *Sci Rep* **14**, 24657 https://doi.org/10.1038/s41598-024-76610-8
101. T.R. Fonville, S.J. Scarola, Y. Hammi, Raj K. Prabhu, Mark F. Horstemeyer. (2022).Chapter 14 - Resonant frequencies of a human brain, skull, and head,Editor(s): Raj Prabhu, Mark Horstemeyer,Multiscale Biomechanical Modeling of the Brain,Academic Press,2022,Pages 239-254,ISBN 9780128181447, https://doi.org/10.1016/B978-0-12-818144-7.00006-2.
102. Young A, Hunt T, Ericson M. (2022).The Slowest Shared Resonance: A Review of Electromagnetic Field Oscillations Between Central and Peripheral Nervous Systems. Front Hum Neurosci. 2022 Feb 16;15:796455. doi: 10.3389/fnhum.2021.796455. PMID: 35250508; PMCID: PMC8888685.
103. Spivey A.(2004). Systems biology: the big picture. Environ Health Perspect. 2004 Nov;112(16):A938-43. doi: 10.1289/ehp.112-a938. PMID: 15598608; PMCID: PMC1247669.
104. Sharma P, Thapliyal A, Chandra T, Singh S, Baduni H, Waheed SM. (2015). Rhythmic breathing: immunological, biochemical, and physiological effects on health. Adv Mind Body Med. 2015 Winter;29(1):18-25. PMID: 25607119.
105. Yasuma F, Hayano J. (2004).Respiratory sinus arrhythmia: why does the heartbeat synchronize with respiratory rhythm? Chest. 2004 Feb;125(2):683-90. doi: 10.1378/chest.125.2.683. PMID: 14769752.
106. Karemaker John M.(2024). Case report: Extreme respiratory sinus arrhythmia in a non-athlete female student - a peculiar finding at the Physiology practicum. Frontiers in Neuroscience. Volume 18 - 2024. URL=https://www.frontiersin.org/journals/neuroscience/articles/10.3389/fnins.2024.1507269. DOI=10.3389/fnins.2024.1507269 ISSN=1662-453X
107. Menuet C, Ben-Tal A, Linossier A, Allen AM, Machado BH, Moraes DJA, Farmer DGS, Paterson DJ, Mendelowitz D, Lakatta EG, Taylor EW, Ackland GL, Zucker IH, Fisher JP, Schwaber JS, Shanks J, Paton JFR, Buron J, Spyer KM, Shivkumar K, Dutschmann M, Joyner MJ, Herring N, Grossman P, McAllen RM, Ramchandra R, Yao ST, Ritz T, Gourine AV. Redefining respiratory sinus arrhythmia as respiratory heart rate variability: an international Expert Recommendation for terminological clarity. Nat Rev Cardiol. 2025 May 6. doi: 10.1038/s41569-025-01160-z. Epub ahead of print. PMID: 40328963.
108. Russo MA, Santarelli DM, O'Rourke D. (2017).The physiological effects of slow breathing in the healthy human. Breathe (Sheff). 2017 Dec;13(4):298-309. doi: 10.1183/20734735.009817. PMID: 29209423; PMCID: PMC5709795.
109. Zaccaro Andrea , Piarulli Andrea , Laurino Marco , Garbella Erika , Menicucci Danilo , Neri Bruno , Gemignani Angelo. (2018). How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing Frontiers in Human Neuroscience Volume 12 - 2018 URL=https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2018.00353 DOI=10.3389/fnhum.2018.00353 ISSN=1662-5161
110. Gurjeet Birdee, Katrina Nelson, Ken Wallston, Hui Nian, Andre Diedrich, Sachin Paranjape, Robert Abraham, Alfredo Gamboa. (2023).Slow breathing for reducing stress: The effect of extending exhale,Complementary Therapies in Medicine,Volume 73,2023,102937,ISSN 0965-2299,https://doi.org/10.1016/j.ctim.2023.102937.(https://www.sciencedirect.com/science/article/pii/S0965229923000249)
111. Luo, Q., Li, X., Zhao, J. *et al.* (2025). The effect of slow breathing in regulating anxiety. *Sci Rep* **15**, 8417 https://doi.org/10.1038/s41598-025-92017-5
112. Lakatos P, Shah AS, Knuth KH, Ulbert I, Karmos G, Schroeder CE. (2005). An oscillatory hierarchy controlling neuronal excitability and stimulus processing in the auditory cortex. J Neurophysiol. 2005 Sep;94(3):1904-11. doi: 10.1152/jn.00263.2005. Epub 2005 May 18. PMID: 15901760.
113. Jerath R, Beveridge C, Jensen M. (2019).On the Hierarchical Organization of Oscillatory Assemblies: Layered Superimposition and a Global Bioelectric Framework. Front Hum Neurosci. 2019 Dec 4;13:426. doi: 10.3389/fnhum.2019.00426. PMID: 31866845; PMCID: PMC6904282.
114. Georg Northoff, Zirui Huang, (2017).How do the brain’s time and space mediate consciousness and its different dimensions? Temporo-spatial theory of consciousness (TTC),Neuroscience & Biobehavioral Reviews,Volume 80,2017,Pages 630-645,ISSN 0149-7634,https://doi.org/10.1016/j.neubiorev.2017.07.013. (https://www.sciencedirect.com/science/article/pii/S0149763417300635)
115. Jerath Ravinder , Beveridge Connor. (2024). Beyond awareness: the binding of reflexive mechanisms with the conscious mind: a perspective from default space theory Frontiers in Human Neuroscience Volume 18 - 2024 URL=https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2024.1520138 DOI=10.3389/fnhum.2024.1520138 ISSN=1662-5161
116. Eilam, E. (2019). Synchronization: a framework for examining emotional climate in classes. *Palgrave Commun* **5**, 144https://doi.org/10.1057/s41599-019-0356-0
117. Fannes, Mark & Wouters, Jeroen. (2010). Quantum processes. 10.1142/9789814317443\_0004.
118. Schwartz JM, Stapp HP, Beauregard M. (2005).Quantum physics in neuroscience and psychology: a neurophysical model of mind-brain interaction. Philos Trans R Soc Lond B Biol Sci. 2005 Jun 29;360(1458):1309-27. doi: 10.1098/rstb.2004.1598. PMID: 16147524; PMCID: PMC1569494.
119. Travis J.A. Craddock, Philip Kurian, Jack A. Tuszynski, Stuart R. Hameroff, (2019). Quantum Processes in Neurophotonics and the Origin of the Brain's Spatiotemporal Hierarchy,Editor(s): Robert R. Alfano, Lingyan Shi,In Nanophotonics,Neurophotonics and Biomedical Spectroscopy,Elsevier,2019,Pages 189-213,ISBN 9780323480673, https://doi.org/10.1016/B978-0-323-48067-3.00009-3.
120. Wang, Z., Liu, M., Ren, X., Cheng, Y. (2013). Research on Electromagnetic Coupling Artificial Neural Network with Spatial Topology. In: Liu, D., Alippi, C., Zhao, D., Hussain, A. (eds) Advances in Brain Inspired Cognitive Systems. BICS 2013. Lecture Notes in Computer Science(), vol 7888. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-38786-9\_7
121. Shin, D., Cho, KH. (2023). Critical transition and reversion of tumorigenesis. *Exp Mol Med* 55, 692–705 https://doi.org/10.1038/s12276-023-00969-3
122. Costello LC, Franklin RB.(2012).The genetic/metabolic transformation concept of carcinogenesis. Cancer Metastasis Rev. 2012 Jun;31(1-2):123-30. doi: 10.1007/s10555-011-9334-8. PMID: 22109079; PMCID: PMC4107361.
123. Chen, D., Lu, S., Huang, K. *et al.* (2025). Cell cycle duration determines oncogenic transformation capacity. *Nature* 641, 1309–1318 https://doi.org/10.1038/s41586-025-08935-x
124. Webb SJ, Geoghegan TE, Prough RA, Michael Miller KK.(2006).The biological actions of dehydroepiandrosterone involves multiple receptors. Drug Metab Rev. 38(1-2):89-116. doi: 10.1080/03602530600569877. PMID: 16684650; PMCID: PMC2423429.
125. Poonam Sahu, Bina Gidwani, H.J. Dhongade. (2020).Pharmacological activities of dehydroepiandrosterone: A review,Steroids,Volume 153,2020,108507,ISSN 0039-128X, <https://doi.org/10.1016/j.steroids.2019.108507>. (https://www.sciencedirect.com/science/article/pii/S0039128X19301977)
126. Neta, M., Haas, I.J. (2019). Movere: Characterizing the Role of Emotion and Motivation in Shaping Human Behavior. In: Neta, M., Haas, I.J. (eds) Emotion in the Mind and Body. Nebraska Symposium on Motivation, vol 66. Springer, Cham. https://doi.org/10.1007/978-3-030-27473-3\_1
127. Bowyer, S.M. Coherence a measure of the brain networks: past and present. *Neuropsychiatr Electrophysiol* **2**, 1 (2016). https://doi.org/10.1186/s40810-015-0015-7
128. Eriksson, M. (2022). The Sense of Coherence: The Concept and Its Relationship to Health. In: Mittelmark, M.B., *et al.* The Handbook of Salutogenesis. Springer, Cham. https://doi.org/10.1007/978-3-030-79515-3\_9
129. Kaiser, Fr. (2014). Coherent Oscillations in Biological Systems I. Zeitschrift für Naturforschung A. 33. 10.1515/zna-1978-0307.
130. Salari, V & Rahnama, M & Bernroider, Gustav. (2011). Plausibility of Quantum Coherent States in Biological Systems. Journal of Physics Conference Series. 306. 012075. 10.1088/1742-6596/306/1/012075.
131. [Marais Adriana](https://royalsocietypublishing.org/author/Marais%2C+Adriana),[Adams Betony](https://royalsocietypublishing.org/author/Adams%2C+Betony),[Ringsmuth Andrew K.](https://royalsocietypublishing.org/author/Ringsmuth%2C+Andrew+K),[Ferretti Marco](https://royalsocietypublishing.org/author/Ferretti%2C+Marco),[Gruber J. Michael](https://royalsocietypublishing.org/author/Gruber%2C+J+Michael),[Hendrikx Ruud](https://royalsocietypublishing.org/author/Hendrikx%2C+Ruud),[Schuld Maria](https://royalsocietypublishing.org/author/Schuld%2C+Maria),[Smith Samuel L.](https://royalsocietypublishing.org/author/Smith%2C+Samuel+L),[Sinayskiy Ilya](https://royalsocietypublishing.org/author/Sinayskiy%2C+Ilya),[Krüger Tjaart P. J.](https://royalsocietypublishing.org/author/Kr%C3%BCger%2C+Tjaart+P+J),[Petruccione Francesco](https://royalsocietypublishing.org/author/Petruccione%2C+Francesco) and [van Grondelle Rienk](https://royalsocietypublishing.org/author/van+Grondelle%2C+Rienk).(2018).The future of quantum biology*J. R. Soc. Interface.***15**20180640
132. McCraty R, Zayas MA.(2014). Cardiac coherence, self-regulation, autonomic stability, and psychosocial well-being. Front Psychol. 2014 Sep 29;5:1090. doi: 10.3389/fpsyg.2014.01090. PMID: 25324802; PMCID: PMC4179616.
133. Bouny, P., Arsac, L. M., Guérin, A., Nerincx, G., & Deschodt-Arsac, V. (2023). Guiding Breathing at the Resonance Frequency with Haptic Sensors Potentiates Cardiac Coherence. Sensors, 23(9), 4494. https://doi.org/10.3390/s23094494
134. John YJ, Sawyer KS, Srinivasan K, Müller EJ, Munn BR, Shine JM.(2022). It's about time: Linking dynamical systems with human neuroimaging to understand the brain. Netw Neurosci. 2022 Oct 1;6(4):960-979. doi: 10.1162/netn\_a\_00230. PMID: 36875012; PMCID: PMC9976648.
135. Gaetano Valenza, Francesco Di Ciò, Nicola Toschi, Riccardo Barbieri; (2024)Sympathetic and parasympathetic central autonomic networks. *Imaging Neuroscience*  2 1–17. doi: <https://doi.org/10.1162/imag_a_00094>
136. Sklerov M, Dayan E, Browner N. (2019). Functional neuroimaging of the central autonomic network: recent developments and clinical implications. Clin Auton Res. 2019 Dec;29(6):555-566. doi: 10.1007/s10286-018-0577-0. Epub 2018 Nov 23. PMID: 30470943; PMCID: PMC6858471.
137. Lisa Quadt, Hugo Critchley, Yoko Nagai. (2022).Cognition, emotion, and the central autonomic network,Autonomic Neuroscience,Volume 238,2022,102948,ISSN 1566-0702,https://doi.org/10.1016/j.autneu.2022.102948.(https://www.sciencedirect.com/science/article/pii/S1566070222000078)
138. Shouman, K., Benarroch, E.E. (2021). Central Autonomic Network. In: Chokroverty, S., Cortelli, P. (eds) Autonomic Nervous System and Sleep. Springer, Cham. https://doi.org/10.1007/978-3-030-62263-3\_2
139. Bradley RT, McCraty R, Atkinson M, Tomasino D, Daugherty A, Arguelles L. (2010).Emotion self-regulation, psychophysiological coherence, and test anxiety: results from an experiment using electrophysiological measures. Appl Psychophysiol Biofeedback. 2010 Dec;35(4):261-83. doi: 10.1007/s10484-010-9134-x. PMID: 20559707.
140. McCraty, R., & Tomasino, D. (2006). Emotional stress, positive emotions, and psychophysiological coherence. In B. B. Arnetz & R. Ekman (Eds.), *Stress in health and disease* (pp. 342–365). Wiley-VCH Veriag GmbH & Co KGaA. [https://doi.org/10.1002/3527609156.ch21](https://psycnet.apa.org/doi/10.1002/3527609156.ch21)
141. McCraty R, Zayas MA. (2014).Cardiac coherence, self-regulation, autonomic stability, and psychosocial well-being. Front Psychol. 2014 Sep 29;5:1090. doi: 10.3389/fpsyg.2014.01090. PMID: 25324802; PMCID: PMC4179616.
142. Gross Elizabeth B. , Medina-DeVilliers Sara E. (2020). Cognitive Processes Unfold in a Social Context: A Review and Extension of Social Baseline Theory Frontiers in Psychology Volume 11 - 2020 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2020.00378 DOI=10.3389/fpsyg.2020.00378 ISSN=1664-1078
143. Coan JA, Sbarra DA.(2015). Social Baseline Theory: The Social Regulation of Risk and Effort. Curr Opin Psychol. 2015 Feb;1:87-91. doi: 10.1016/j.copsyc.2014.12.021. PMID: 25825706; PMCID: PMC4375548.
144. Lane Beckes, David A. Sbarra. (2022).Social baseline theory: State of the science and new directions,Current Opinion in Psychology,Volume 43,2022,Pages 36-41,ISSN 2352-250X,https://doi.org/10.1016/j.copsyc.2021.06.004.(https://www.sciencedirect.com/science/article/pii/S2352250X21000737)
145. Sciutti Alessandra , Damonte Federica , Alloisio Marta , Sandini Giulio. (2019). Visuo-Haptic Exploration for Multimodal Memory Frontiers in Integrative Neuroscience Volume 13 - 2019 URL=https://www.frontiersin.org/journals/integrative-neuroscience/articles/10.3389/fnint.2019.00015 DOI=10.3389/fnint.2019.00015 ISSN=1662-5145
146. Reinberg A, Ashkenazi I. (2003). Concepts in human biological rhythms. Dialogues Clin Neurosci. 2003 Dec;5(4):327-42. doi: 10.31887/DCNS.2003.5.4/areinberg. PMID: 22033796; PMCID: PMC3181781.
147. Pelletier LG, Guertin C, Pope JP, Rocchi M.(2016). Homeostasis balance, homeostasis imbalance or distinct motivational processes? Comments on Marks (2015) 'Homeostatic Theory of Obesity'. Health Psychol Open. 2016 Jan 13;3(1):2055102915624512. doi: 10.1177/2055102915624512. PMID: 28070384; PMCID: PMC5193284.
148. Schmidt, S. (2015). Experimental research on distant intention phenomena. In E. Cardeña, J. Palmer, & D. Marcusson-Clavertz (Eds.), *Parapsychology: A handbook for the 21st century* (pp. 244–257). McFarland & Co.
149. Plonka, Nachum & McCraty, Rollin & Welss, Claudia. (2024). The Path to Global Coherence: The Role of the Global Consciousness Project 2.0. Journal of Management, Spirituality & Religion. 10.51327/UDIY4331.
150. McCraty R, Deyhle A, Childre D.(2012).The global coherence initiative: creating a coherent planetary standing wave. Glob Adv Health Med. 2012 Mar;1(1):64-77. doi: 10.7453/gahmj.2012.1.1.013. PMID: 24278803; PMCID: PMC3833489.
151. Whitson HE, Cohen HJ, Schmader KE, Morey MC, Kuchel G. (2018). Colon-Emeric CS. Physical Resilience: Not Simply the Opposite of Frailty. J Am Geriatr Soc. 2018 Aug;66(8):1459-1461. doi: 10.1111/jgs.15233. Epub 2018 Mar 25. PMID: 29577234; PMCID: PMC6157007.
152. Manning, J., Heselton, H.J., Venema, D.M. *et al.* (2025).Defining the concept of physical resilience and quantifying recovery during standing balance in middle-aged and older adults. *Sci Rep* **15**, 7988 (2025). https://doi.org/10.1038/s41598-025-92746-7
153. Manning L, Ferris M, Rosario CN, Prues M, Bouchard L.(2019). Spiritual resilience: Understanding the protection and promotion of well-being in the later life. J Relig Spiritual Aging. 2019;31(2):168-186. doi: 10.1080/15528030.2018.1532859. Epub 2018 Oct 31. PMID: 33335455; PMCID: PMC7743140.
154. Güldaş, F. Z., & Karslı, F. (2023). Exploring the moderating effect of spiritual resilience on the relationship between psychological resilience and mental health. Spiritual Psychology and Counseling, 8(3), 349–366. http://doi.org/10.37898/spiritualpc.1344542
155. Denckla CA, Cicchetti D, Kubzansky LD, Seedat S, Teicher MH, Williams DR, Koenen KC. (2020).Psychological resilience: an update on definitions, a critical appraisal, and research recommendations. Eur J Psychotraumatol. 2020 Nov 10;11(1):1822064. doi: 10.1080/20008198.2020.1822064. PMID: 33244362; PMCID: PMC7678676.
156. Afek Anat , Ben-Avraham Rina , Davidov Alexander , Berezin Cohen Noa , Ben Yehuda Ariel , Gilboa Yafit , Nahum Mor. (2021). Psychological Resilience, Mental Health, and Inhibitory Control Among Youth and Young Adults Under Stress Frontiers in Psychiatry Volume 11 – 2020, URL=https://www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2020.608588 DOI=10.3389/fpsyt.2020.608588 ISSN=1664-0640
157. Watt, C. (2005). Parapsychology (R. Wiseman, Ed.) (1st ed.). Routledge. <https://doi.org/10.4324/9781315247366>
158. Morris Freedman, Malcolm Binns, Fuqiang Gao, Melissa Holmes, Austyn Roseborough, Stephen Strother, Antonino Vallesi, Stanley Jeffers, Claude Alain, Peter Whitehouse, Jennifer D. Ryan, Robert Chen, Michael D. Cusimano, Sandra E. Black. (2017).Mind–Matter Interactions and the Frontal Lobes of the Brain: A Novel Neurobiological Model of Psi Inhibition,EXPLORE, Volume 14, Issue 1,2018,Pages 76-85,ISSN 1550-8307,https://doi.org/10.1016/j.explore.2017.08.003. (https://www.sciencedirect.com/science/article/pii/S1550830717301453)
159. Basile GA, Tatti E, Bertino S, Milardi D, Genovese G, Bruno A, Muscatello MRA, Ciurleo R, Cerasa A, Quartarone A, Cacciola. (2024). A. Neuroanatomical correlates of peripersonal space: bridging the gap between perception, action, emotion and social cognition. Brain Struct Funct. 2024 Jun;229(5):1047-1072. doi: 10.1007/s00429-024-02781-9. Epub 2024 Apr 29. PMID: 38683211; PMCID: PMC11147881.
160. Cardena E. (2025). What psi research can and can not, say about mind beyond th ebrain. International Review of Psychiatry., 1-5.https://doi.org/10.1080/09540261.2025.2466485.
161. Shiah, Yung-Jong & Chang, Frances. (2009). Possible factors affecting or relating to Psi and Psi’s difficulty. The Journal of Kaohsiung Behavior Sciences(高雄行為科學學刊). 1. 1-24.
162. Hirata, S., Watanabe, K., Masao, K. (2008). “Sweet-Potato Washing” Revisited. In: Matsuzawa, T. (eds) Primate Origins of Human Cognition and Behavior. Springer, Tokyo. https://doi.org/10.1007/978-4-431-09423-4\_24
163. Watanabe, K. (2008). A Review of 50 Years of Research on the Japanese Monkeys of Koshima: Status and Dominance. In: Matsuzawa, T. (eds) Primate Origins of Human Cognition and Behavior. Springer, Tokyo. https://doi.org/10.1007/978-4-431-09423-4\_20
164. Chen, A., Heyl, M. (2024).Empowering deep neural quantum states through efficient optimization. *Nat. Phys.* 20, 1476–1481 (2024). https://doi.org/10.1038/s41567-024-02566-1
165. Burgin, M., & Mikkilineni, R. (2022). Is Information Physical and Does It Have Mass? Information, 13(11), 540. https://doi.org/10.3390/info13110540
166. Bush NE, Greyson B.(2014). Distressing near-death experiences: the basics. Mo Med. 2014 Nov-Dec;111(6):486-90. PMID: 25665233; PMCID: PMC6173534.
167. Martial, C., Fritz, P., Gosseries, O. *et al.* (2025). A neuroscientific model of near-death experiences. *Nat Rev Neurol* 21, 297–311 <https://doi.org/10.1038/s41582-025-01072-z>
168. Wulff, D. M. (2000). Mystical experience. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience: Examining the scientific evidence* (pp. 397–440). American Psychological Association. [https://doi.org/10.1037/10371-012](https://psycnet.apa.org/doi/10.1037/10371-012)
169. Gaiseanu, Florin (2019). The Informational Model of Consciousness: Mechanisms of Embodiment/Disembodiment of Information. Neuroquantology 17 (4):1-17.
170. Ishii, Shan et al. eLife 2023;12:e84488. DOI: <https://doi.org/10.7554/eLife.84488>
171. Shen L, Yang W. (2018). Molecular Dynamics Simulations with Quantum Mechanics/Molecular Mechanics and Adaptive Neural Networks. J Chem Theory Comput. 2018 Mar 13;14(3):1442-1455. doi: 10.1021/acs.jctc.7b01195. Epub 2018 Feb 26. PMID: 29438614; PMCID: PMC6233882.
172. van Mourik T, Bühl M, Gaigeot MP.(2014). Density functional theory across chemistry, physics and biology. Philos Trans A Math Phys Eng Sci. 2014 Feb 10;372(2011):20120488. doi: 10.1098/rsta.2012.0488. PMID: 24516181; PMCID: PMC3928866.
173. Orio, M., Pantazis, D.A. & Neese, F. (2009). Density functional theory. *Photosynth Res* 102, 443–453 https://doi.org/10.1007/s11120-009-9404-8
174. Andrews, David & Bradshaw, David. (2009). Resonance Energy Transfer. 10.1002/3527600434.eap685.
175. Jones Garth A. , Bradshaw David S.(2019). Resonance Energy Transfer: From Fundamental Theory to Recent Applications Frontiers in Physics Volume 7 - 2019 URL=https://www.frontiersin.org/journals/physics/articles/10.3389/fphy.2019.00100 DOI=10.3389/fphy.2019.00100 ISSN=2296-424X
176. Andrews, D. L., & Bradshaw, D. S. (2022). Controlling Electronic Energy Transfer: A Systematic Framework of Theory. Applied Sciences, 12(17), 8597. https://doi.org/10.3390/app12178597
177. Kong, FF., Tian, XJ., Zhang, Y. *et al.* (2022). Wavelike electronic energy transfer in donor–acceptor molecular systems through quantum coherence. *Nat. Nanotechnol.* 17, 729–736 https://doi.org/10.1038/s41565-022-01142-z
178. Artyukhov, Victor & Mayer, G.. (2000). A Theory of Electronic Energy Transfer in Complex Molecular Systems. Russian Physics Journal - RUSS PHYS J. 43. 829-833. 10.1023/A:1009480632741.
179. Ullah, A., Dral, P.O. (2022). Predicting the future of excitation energy transfer in light-harvesting complex with artificial intelligence-based quantum dynamics. *Nat Commun* **13**, 1930 https://doi.org/10.1038/s41467-022-29621-w
180. Oroszi T, van Heuvelen MJG, Nyakas C, van der Zee EA. (2020). Vibration detection: its function and recent advances in medical applications. F1000Res. 2020 Jun 17;9:F1000 Faculty Rev-619. doi: 10.12688/f1000research.22649.1. PMID: 32595943; PMCID: PMC7308885.
181. Sastry, Girish & Heim, Lennart & Belfield, Haydn & Anderljung, Markus & Brundage, Miles & Hazell, Julian & O'Keefe, Cullen & Hadfield, Gillian & Ngo, Richard & Pilz, Konstantin & Gor, George & Bluemke, Emma & Shoker, Sarah & Egan, Janet & Trager, Robert & Avin, Shahar & Weller, Adrian & Bengio, Yoshua & Coyle, Diane. (2024). Computing Power and the Governance of Artificial Intelligence.
182. Gebicke-Haerter Peter J. (2023).The computational power of the human brain. Frontiers in Cellular Neuroscience Volume 17 - 2023 URL=https://www.frontiersin.org/journals/cellular-neuroscience/articles/10.3389/fncel.2023.1220030 DOI=10.3389/fncel.2023.1220030 ISSN=1662-5102
183. Li, T., He, B., & Zheng, Y. (2023). Research and Implementation of High Computational Power for Training and Inference of Convolutional Neural Networks. Applied Sciences, 13(2), 1003. https://doi.org/10.3390/app13021003
184. Karamanlis, D., Khani, M.H., Schreyer, H.M. *et al.* (2025). Nonlinear receptive fields evoke redundant retinal coding of natural scenes. *Nature* **637**, 394–401 <https://doi.org/10.1038/s41586-024-08212-3>
185. Silva, Ivan & Spatti, Danilo & Flauzino, R.A. & Bartocci Liboni, Luisa & Reis Alves, Silas. (2017). Artificial Neural Network Architectures and Training Processes. 10.1007/978-3-319-43162-8\_2.
186. Rahman, M., Haider, Z. & Chakraborty, P. (2025). An automated multi parameter neural architecture discovery framework using ChatGPT in the backend. *Sci Rep* **15**, 16871 <https://doi.org/10.1038/s41598-025-97378-5>
187. Hirata Y, Katori Y, Shimokawa H, Suzuki H, Blenkinsop TA, Lang EJ, Aihara K. (2008).Testing a neural coding hypothesis using surrogate data. J Neurosci Methods. 2008 Jul 30;172(2):312-22. doi: 10.1016/j.jneumeth.2008.05.004. Epub 2008 May 15. PMID: 18565591; PMCID: PMC2529148.
188. Yao JD, Sanes DH. (2021).Temporal Encoding is Required for Categorization, But Not Discrimination. Cereb Cortex. 2021 May 10;31(6):2886-2897. doi: 10.1093/cercor/bhaa396. PMID: 33429423; PMCID: PMC8107795.
189. Price Byron H. , Gavornik Jeffrey P.(2022). Efficient Temporal Coding in the Early Visual System: Existing Evidence and Future DirectionsFrontiers in Computational Neuroscience Volume 16 – 2022URL=https://www.frontiersin.org/journals/computational-neuroscience/articles/10.3389/fncom.2022.929348DOI=10.3389/fncom.2022.929348 ISSN=1662-5188
190. Mangold SA, Das JM. [Updated 2023 Jul 24]. Neuroanatomy, Cortical Primary Auditory Area. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK554521/>
191. Andres Carrasco, Melanie A. Kok, Stephen G. Lomber. (2015).Effects of Core Auditory Cortex Deactivation on Neuronal Response to Simple and Complex Acoustic Signals in the Contralateral Anterior Auditory Field, Cerebral Cortex, Volume 25, Issue 1, January 2015, Pages 84–96, <https://doi.org/10.1093/cercor/bht205>
192. Bubic A, von Cramon DY, Schubotz RI. (2010).Prediction, cognition and the brain. Front Hum Neurosci. 2010 Mar 22;4:25. doi: 10.3389/fnhum.2010.00025. PMID: 20631856; PMCID: PMC2904053.
193. Fan J. (2014).An information theory account of cognitive control. Front Hum Neurosci. 2014 Sep 2;8:680. doi: 10.3389/fnhum.2014.00680. PMID: 25228875; PMCID: PMC4151034.
194. Lee Kwangjun, Dora Shirin , Mejias Jorge F. , Bohte Sander M. , Pennartz Cyriel M. A. (2024). Predictive coding with spiking neurons and feedforward gist signaling Frontiers in ComputationalNeuroscienceVolume18 -URL=https://www.frontiersin.org/journals/computationalneuroscience/articles/10.3389/fncom.2024.1338280 DOI=10.3389/fncom.2024.1338280 ISSN=1662-5188
195. Mastrogiorgio Antonio. (2022). A Quantum Predictive Brain: Complementarity Between Top-Down Predictions and Bottom-Up Evidence Frontiers in Psychology Volume 13 - 2022 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.869894 DOI=10.3389/fpsyg.2022.869894 ISSN=1664-1078
196. Haarsma, J., Fletcher, P.C., Griffin, J.D. *et al.* (2021). Precision weighting of cortical unsigned prediction error signals benefits learning, is mediated by dopamine, and is impaired in psychosis. *Mol Psychiatry* **26**, 5320–5333 https://doi.org/10.1038/s41380-020-0803-8
197. Daniel Yon, Chris D. Frith,Precision and the Bayesian brain,Current Biology,Volume 31, Issue 17,2021,Pages R1026-R1032,ISSN 0960-9822,<https://doi.org/10.1016/j.cub.2021.07.044>. (https://www.sciencedirect.com/science/article/pii/S0960982221010344)
198. Junyi Chai, Eric W.T. Ngai. (2020).The variable precision method for elicitation of probability weighting functions,Decision Support Systems,Volume 128,2020,113166, ISSN 0167-9236, <https://doi.org/10.1016/j.dss.2019.113166>. (https://www.sciencedirect.com/science/article/pii/S0167923619301952)
199. Dixon Matthew L. (2015).Cognitive control, emotional value, and the lateral prefrontal cortex Frontiers in Psychology Volume 6 – 2015 URL=https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2015.00758 DOI=10.3389/fpsyg.2015.00758 ISSN=1664-1078
200. Friedman, N.P., Robbins, T.W. (2022). The role of prefrontal cortex in cognitive control and executive function. *Neuropsychopharmacol.* **47**, 72–89 https://doi.org/10.1038/s41386-021-01132-0
201. R. Frömer, A. Shenhav.(2021). Filling the gaps: Cognitive control as a critical lens for understanding mechanisms of value-based decision-making, Neuroscience & Biobehavioral Reviews, Volume 134, 2022, 104483, ISSN 0149-7634,<https://doi.org/10.1016/j.neubiorev.2021.12.006>. (<https://www.sciencedirect.com/science/article/pii/S0149763421005546>)
202. Liu, Z., & Yin, X. (2025). A Review of Cognitive Control: Advancement, Definition, Framework, and Prospect. Actuators, 14(1), 32. <https://doi.org/10.3390/act14010032>
203. Ganesan, K., Thompson, A., Smid, C.R. *et al.* (2024). Cognitive control training with domain-general response inhibition does not change children’s brains or behavior. *Nat Neurosci* **27**, 1364–1375 <https://doi.org/10.1038/s41593-024-01672-w>
204. Mackie MA, Van Dam NT, Fan J. (2013).Cognitive control and attentional functions. Brain Cogn. 2013 Aug;82(3):301-12. doi: 10.1016/j.bandc.2013.05.004. Epub 2013 Jun 19. PMID: 23792472; PMCID: PMC3722267.
205. Grim, P., Rescher, N. (2023). Influence theory. *Synthese* **201**, 211 https://doi.org/10.1007/s11229-023-04163-w
206. Guskjolen, A., Cembrowski, M.S. (2023). Engram neurons: Encoding, consolidation, retrieval, and forgetting of memory. *Mol Psychiatry* **28**, 3207–3219 https://doi.org/10.1038/s41380-023-02137-5
207. Josselyn SA, Tonegawa S. (2020).Memory engrams: Recalling the past and imagining the future. Science. 2020 Jan 3;367(6473):eaaw4325. doi: 10.1126/science.aaw4325. PMID: 31896692; PMCID: PMC7577560.
208. Miry Omid , Li Jie , Chen Lu (2021). The Quest for the Hippocampal Memory Engram: From Theories to Experimental Evidence Frontiers in Behavioral Neuroscience Volume 14 – 2020 URL=https://www.frontiersin.org/journals/behavioral-neuroscience/articles/10.3389/fnbeh.2020.632019 DOI=10.3389/fnbeh.2020.632019 ISSN=1662-5153
209. Poo, Mm., Pignatelli, M., Ryan, T.J. *et al.* (2016). What is memory? The present state of the engram. *BMC Biol* **14**, 40 https://doi.org/10.1186/s12915-016-0261-6
210. Zaki, Y., Cai, D.J. (2025). Memory engram stability and flexibility. *Neuropsychopharmacol.* 50, 285–293 https://doi.org/10.1038/s41386-024-01979-z
211. M.R. Lopez, S.M.H. Wasberg, C.M. Gagliardi, M.E. Normandin, I.A. Muzzio,Mystery of the memory engram: History, current knowledge, and unanswered questions, Neuroscience & Biobehavioral Reviews, Volume 159,2024, 105574,ISSN 0149-7634, <https://doi.org/10.1016/j.neubiorev.2024.105574>. (https://www.sciencedirect.com/science/article/pii/S0149763424000435)
212. Letellier Mathieu , Cingolani Lorenzo A. (2021).Editorial: Homeostatic Synaptic Plasticity: From Synaptic Circuit Assembly to Neurological Disorders Frontiers in Cellular NeuroscienceVolume 15 - 2021 URL=https://www.frontiersin.org/journals/cellular neuroscience/articles/10.3389/fncel.2021.695313 DOI=10.3389/fncel.2021.695313 ISSN=1662-5102
213. Kavalali, E.T., Monteggia, L.M. (2023). Rapid homeostatic plasticity and neuropsychiatric therapeutics. *Neuropsychopharmacol.* 48, 54–60 <https://doi.org/10.1038/s41386-022-01411-4>
214. Turrigiano G. Homeostatic synaptic plasticity: local and global mechanisms for stabilizing neuronal function. Cold Spring Harb Perspect Biol. 2012 Jan 1;4(1):a005736. doi: 10.1101/cshperspect.a005736. PMID: 22086977; PMCID: PMC3249629.
215. Lee Hey-Kyoung , Kirkwood Alfredo. (2019). Mechanisms of Homeostatic Synaptic Plasticity in vivo Frontiers in Cellular Neuroscience Volume 13 – 2019 URL=https://www.frontiersin.org/journals/cellular- neuroscience/articles/10.3389/fncel.2019.00520 DOI=10.3389/fncel.2019.00520 ISSN=1662-5102
216. Winocur, Gordon & Moscovitch, Morris. (2011). Memory Transformation and Systems Consolidation. Journal of the International Neuropsychological Society : JINS. 17. 766-80. 10.1017/S1355617711000683.
217. Squire LR, Genzel L, Wixted JT, Morris RG. (2015).Memory consolidation. Cold Spring Harb Perspect Biol. 2015 Aug 3;7(8):a021766. doi: 10.1101/cshperspect.a021766. PMID: 26238360; PMCID: PMC4526749.
218. Yadin Dudai, Avi Karni, Jan Born. (2015). The Consolidation and Transformation of Memory, Neuron, Volume 88, Issue 1, 2015, Pages 20-32, ISSN 0896-6273, <https://doi.org/10.1016/j.neuron.2015.09.004>. (<https://www.sciencedirect.com/science/article/pii/S0896627315007618>)
219. Cowan, E.T., Schapiro, A.C., Dunsmoor, J.E. *et al.* (2021). Memory consolidation as an adaptive process. *Psychon Bull Rev* **28**, 1796–1810 <https://doi.org/10.3758/s13423-021-01978-x>
220. Paul Greengard. (2001).The Neurobiology of Slow Synaptic Transmission.*Science***294**,1024-1030DOI:[10.1126/science.294.5544.1024](https://doi.org/10.1126/science.294.5544.1024)
221. Turrigiano GG.(2008). The self-tuning neuron: synaptic scaling of excitatory synapses. Cell. 2008 Oct 31;135(3):422-35. doi: 10.1016/j.cell.2008.10.008. PMID: 18984155; PMCID: PMC2834419.
222. Stellwagen, D., Malenka, R. (2006). Synaptic scaling mediated by glial TNF-α. *Nature* 440, 1054–1059 https://doi.org/10.1038/nature04671
223. Fong, Mf., Newman, J., Potter, S. *et al.* (2015). Upward synaptic scaling is dependent on neurotransmission rather than spiking. *Nat Commun* **6**, 6339 https://doi.org/10.1038/ncomms7339
224. Chi-Hong Wu, Raul Ramos, Donald B. Katz, Gina G. (2021)Turrigiano,Homeostatic synaptic scaling establishes the specificity of an associative memory,Current Biology,Volume 31, Issue 11,2021,Pages 2274-2285.e5,ISSN 0960-9822,https://doi.org/10.1016/j.cub.2021.03.024.(https://www.sciencedirect.com/science/article/pii/S0960982221003638)
225. Gainey MA, Hurvitz-Wolff JR, Lambo ME, Turrigiano GG. (2009)Synaptic scaling requires the GluR2 subunit of the AMPA receptor. J Neurosci. 2009 May 20;29(20):6479-89. doi: 10.1523/JNEUROSCI.3753-08.2009. PMID: 19458219; PMCID: PMC2714274.
226. Branco, T., Staras, K. (2009). The probability of neurotransmitter release: variability and feedback control at single synapses. *Nat Rev Neurosci* **10**, 373–383 https://doi.org/10.1038/nrn2634
227. Millar AG, Bradacs H, Charlton MP, Atwood HL.(2002) Inverse relationship between release probability and readily releasable vesicles in depressing and facilitating synapses. J Neurosci. 2002 Nov 15;22(22):9661-7. doi: 10.1523/JNEUROSCI.22-22-09661.2002. PMID: 12427821; PMCID: PMC6757826.
228. Daniela Ivanova et al. (2021).Control of synaptic vesicle release probability via VAMP4 targeting to endolysosomes.*Sci. Adv.***7**,eabf3873.DOI:[10.1126/sciadv.abf3873](https://doi.org/10.1126/sciadv.abf3873)