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Inquiring into the Foundations of Yoga by Exploring the Subconscious Mind and Placebo Effect

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Abstract:

The ancient as well as contemporary yogis of India are believed to have achieved mastery over their mind and body. Through the practice of yoga, they create a certain psychological environment within the mind-body system which provides them access to the functions of the autonomic systems of the body. Many people have reported that in addition to having control of their somatic function (which comes under the radar of the conscious intelligence of the mind), yogis could expand their consciousness into the areas which, as per modern academic understanding, still lie in the subconscious zone. Just by living in their specific environment, some of them can sustain themselves without food, some can resist extremely painful stimuli, and some can live a long life without disease. Understanding and applying these methods can bring a significant amount of change in the type of medicine we practice today. Comprehending the biological mechanism behind this can be helpful in creating a holistic healthcare system for the public. But while modern medicine is evidence-based, the art of yoga is not. In this paper, we have reviewed biological environments based on modern medical sciences suitable for understanding subconscious systems in the context of placebo analgesia in the human body.

Keywords: autonomic systems, placebo analgesia, subconscious mind, *samyama*, *siddhi*

INTRODUCTION

Yoga, the word which in today's world means a set of postures having an Indian origin and providing some benefits to health, has rather a deeper and perhaps a simpler meaning. Yoga means, both literally and practically, 'union'. Broadly, it may mean a lot of things. Union of

mind and body, union of the mind-body with the environment, union of conscious mind with the subconscious mind, union of our intelligence with the cosmic intelligence, union of ancient medicine with modern medicine, and so on.

One of the most prominent works on this subject is Patanjali's Yoga Sutra. It not only discusses the components of 'Aṣṭāṅga Yoga' (an eight-limbed path towards achieving the state of yoga) but also the composition of human personality. The Sutras mention that every individual has a unique personality which is the basis of their identity. This personality is the result of the interplay of a large variety of 'vritti' (variations) which occur in random compositions to uniquely individualize a person's identity. And based on this, there exists a unique psychology of every individual which, in turn, leads to their unique perception of the world.

The Sutras also mention that deep within, at the very fundamental level of consciousness, we are all same. It also guides us in various ways to swim through the barriers of the 'vritti' (variations) to achieve a union with our fundamental consciousness which allows us to have a full control over our mind and body including our health and disease states.

«The development of *Homo sapiens* as a species is considered the pinnacle of evolution because no other species have ever had such dominance over the resources of our planet be it biotic or abiotic (Sherwood et al. 2008). While the human body has transformed significantly during evolution, the key differentiator of the human species is the transformation of the brain. The way humans can think and execute motor functions with high accuracy and flexibility has by far been the most distinguishing feature that makes humans unique and different from other animals.» Reflection is the unique ability of human beings and it requires the mind. As per the current scientific research, most of the mind lies in the subconscious area in all species (Knox, 2003).

Let us try to understand the concept of reflection further using the example of "experiencing a galaxy". «The light falling from a distant galaxy reaches the eyes and neurons process that information and make an individual 'see' the galaxy. However, each individual experiences the galaxy in a different way, ranging from exclamation and curiosity to minimal reaction. This emotional response is related to the psychology of the individual which, in turn, is related to the subconscious mind. Science tries to explain this using the concept of chemical response in our brain. Our subconscious system creates some chemicals which generate corresponding thoughts and emotions.» These thoughts and emotions are the 'reflections' of the individual. The way our brain processes the reflections is itself a multidisciplinary idea. Appreciating the processes requires an understanding of natural sciences, biology, chemistry, philosophy, and many other branches of study. In this paper, we explore the mind (conscious as well as subconscious) and the mechanism of the placebo effect through biological sciences and psychology.

THE MIND

A study was carried out by Gopnik et al. (1992) which mentions different theories of mind. Here, the authors share an argument on why the child theory of mind (the understanding that people do not share the same thoughts and feelings as you do) could explain behavioural aspects of an individual. «In general, we find that every individual has their signature psychology, for example, some may like a mango fruit, some many like eating an orange, some may like the food as bitter as bitter gourd and some may not like to eat at all, some may like sports, some enjoy painting, some love to trek and with the same emotion some may like the universe.» The likes, dislikes, ideas, ways of living cannot be the same for every individual. All the behavioural aspects of an individual are based on cognition through the identified “self” (Knox, 2003). In a recent study it was noted that identity-oriented training could facilitate contact quality as a socioemotional outcome. It can reduce stereotype threats (Burmeister et al. 2021). In other words, this study also supports the idea that the behaviour of an individual is related to his identity. As previously discussed, Yoga Sutras also state that the personality of an individual is the result of the interplay of a large variety of ‘vritti’. The commonalities between these two concepts demonstrate that the approach modern science takes towards studying human personality aligns closely with yogic principles.

«We have dissected the human body, cracked its code to very fundamental principles and understand almost completely the human anatomy and physiology. This knowledge has helped us identify various methods to cure numerous illnesses and a lot of research work is still in progress to explore the remaining unknowns. This progress can be attributed to our “intelligence”. It is the result of intelligence that today we are not just discovering possibilities but also creating possibilities.

The term intelligence, as used in the above context, is a property which is related to the brain. To exercise intelligence our brain must be both active and awake. The awake state of the brain, or what we call wakefulness, is the result of the process called cerebral arousal. This happens because of the impulses sent by RAS (reticular activating system) to the cerebral cortex. In simple language, brain is like a battery that needs regular recharging. By the end of the day, it wears off and you must sleep to recharge it. So, we can define sleep as that state when your RAS is not active and your brain is not awake.

But even when our brain is not awake, it is active. It still keeps regulating various autonomic functions such as breathing, heartbeat, circulation, digestion, cell division, etc. (Maldonato, 2014). These autonomic activities do not have much to do with how awake our brain is. There is an altogether different phenomenon which is related to with these activities. We can call this phenomenon as the subconscious intelligence of our body. The autonomic activities happen in our subconscious mind which accounts for the majority of our mind. The instructions of how to process heart-beat, how to process the breath, how and when to activate hidden memories, are within the subconscious mind.»

Similarly, the feeling of pain is also controlled by the subconscious mind. Sometimes, a particular subconscious response is enough to provide relief from pain. This subconscious response can be triggered by a placebo and is called the placebo effect. The placebo effect is observed not just in pain relief but in other diseases too. However, we will focus specifically on pain relief while discussing placebo effect in this paper.

THE PLACEBO EFFECT

«Placebos are inert drugs that are not therapeutic, but when consumed, they may cause some symptomatic relief in certain individuals. They are biochemical compounds like normal saline, sugar etc., but, when they are administered into the body in the form of medicine, there is an actual response to them without the cognizance of our conscious-intelligence system. Placebos appear to trick our mind-body system into creating certain effects like pain relief, feeling refreshed etc.

Since a sugar pill cannot have any other impact on the body other than to increase the blood sugar level to a limited extent, it implies that certain endogenous mechanisms of the body itself are activated by this pseudo-drug. So, what placebo does is, works behind the cognizance of our conscious-intelligence system, bringing out certain changes in the body which, in turn, have the desired physiological effect.»

MECHANISM OF PLACEBO

«As per a study, placebo causes pain relief through an Endogenous Opioid Release Mechanism. This mechanism involves a process by which our body causes the release of endogenous opioids (Levine et al. 1978). Opioids are substances like morphine which are derived from the opium plant. And endogenous opioids are the opioids that are produced by the body. These endogenous opioids are endorphins and enkephalins.» Incidentally, we find mention of Soma (which is believed to provide disease-free life to an individual) in Rig Veda having characteristics similar to plants releasing opioids. (Kashyap, 2007).

Before discussing the relation of placebo drugs and subconscious mind in the context of benefits of yoga, we need to understand the mechanism by which placebos work.

«The midbrain has a central canal called the cerebral aqueduct for the circulation of the cerebrospinal fluid, which is important for the nourishment of the brain. The aqueduct is the part of the ventricular system of the brain and the CNS (central nervous system). Along its periphery, the aqueduct is surrounded by a variety of neurons (nerve cells) which form dark aggregations collectively called the peri-aqueductal gray (PAG). The neurons of PAG are

enkephalinergic, which means that on stimulation they release enkephalins (opioids). These enkephalins provide analgesia by exerting various inhibitory effects on the pain afferents (the nerve fibres that carry pain from the affected area to the higher centres in the CNS) (Vaz and Raj,2016).»

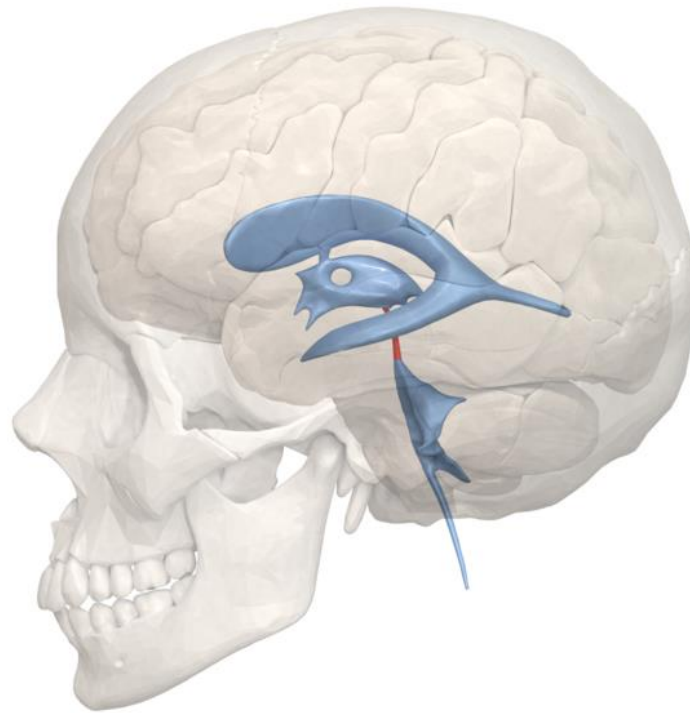


Figure 1: Cerebral Aqueduct (Source: Wikimedia Commons under fair use policy)

«Studies have shown that this pathway is activated in the analgesia initiated by the placebo drugs (Levine et al. 1978). But while this happens in all of the placebo-responders (placebo-responders are people who experience pain relief after receiving placebo), it doesn't happen in everyone. Theoretically, only one-third of the population are placebo-responders, and the rest are non-responders (Lasagna et al. 1954). Now the question arises why is this mechanism activated in only a fraction of the people? What makes them different? To discuss this we have to look into the dimension of psychology and behaviour which will further pave our way for appreciating the mind-body relationship.»

PSYCHO-PHYSIOLOGY OF PLACEBO-RESPONDERS

«The discussion on psychology of the placebo responders is required because placebo does not work in every individual. People who respond have some common characteristic psychology which seems to play an important role in producing the desired response to the pseudo-drugs.

Some studies suggest that placebos work in relatively elder people (>5 years from the non-responders), people who have strong religious faith and people who are more optimistic about the situations they are in (Cherniack, 2010). They complain less about the hospital care they receive, they were relatively happier and more cooperative; their opinions are frank and they are more emotionally expressive (Lasagna et al. 1954). Also, the responders were less formally educated than the non-responders, but they had, on average, similar IQ to that of the non-responders. The non-responders, were found to be of a more peculiar character, fussy, unsatisfied and with pessimistic mindset and they even talked and expressed less (Lasagna et al. 1954).»

The information provided by the aforementioned studies lead us to understand that, when given a placebo, a certain group of people having an overall positive mindset responded positively to placebo and reported acquiring analgesia. This group (the responders) consisted of people who were old, less educated, had faith and were optimistic.

But how can an overall positive mindset lead to the relief of deep pain, when the physiology of the body of every human is the same?

BIOLOGY AND PLACEBO RESPONSE

«When a placebo-responder takes a placebo pill, the mind is reminded about the memory of using a drug for this circumstance. Memories are present in the form of various neurons present in our cerebral-cortex in the region called the hippocampus and para-hippocampal regions of the limbic lobe. Mind associates a certain emotion to the memories you have about modern healthcare, drugs, faith, etc (Rolls, 2008). These memories can be due your personal experiences or due to experiences shared by others. If the emotions associated with these memories are optimistic, the corresponding neurons are fired and the associated region in the brain is activated. These emotional impulses are carried through a bundle of white fibres (nerve fibres in the CNS) called fornix, which forms a part of the Papez circuit.»

«The Papez circuit is a reverberating circuit responsible for the arousal of thoughts in your brain when emotional centres fire. The Papez circuit gives significant information to the cingulum. The cingulum is another centre to process emotions. But it has another important feature too. Some of the slow/deep-pain afferent fibres carrying visceral pain (pain from the viscera or organs) terminate here. So, at this level, there can be inhibition of pain to some extent (Levine et al. 1978)»

Also, some fibres of the Papez circuit (especially fornix) are reported to show termination in the peri-aqueductal gray (PAG) region of the mid-brain in rats (MacLean, 1955). While there are no experiments performed on human subjects to prove the existence of such branchings

from the fornix connecting to the peri-aqueductal gray region of the mid-brain, we can assume a similar connection in human CNS.

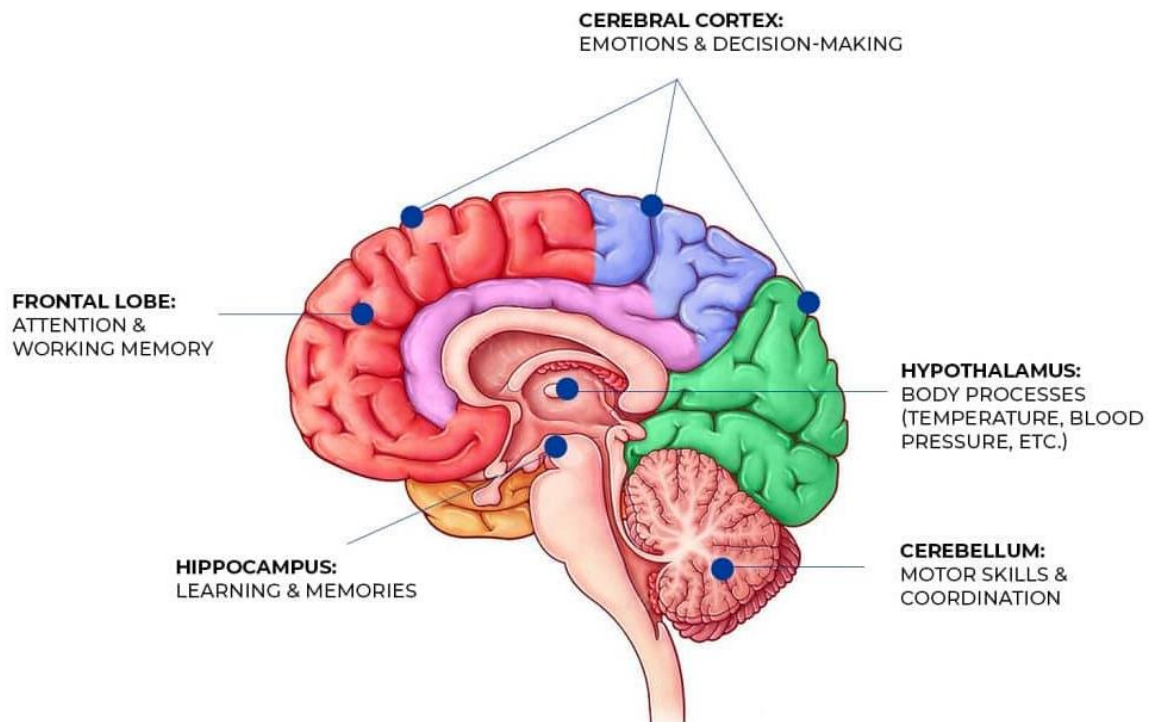
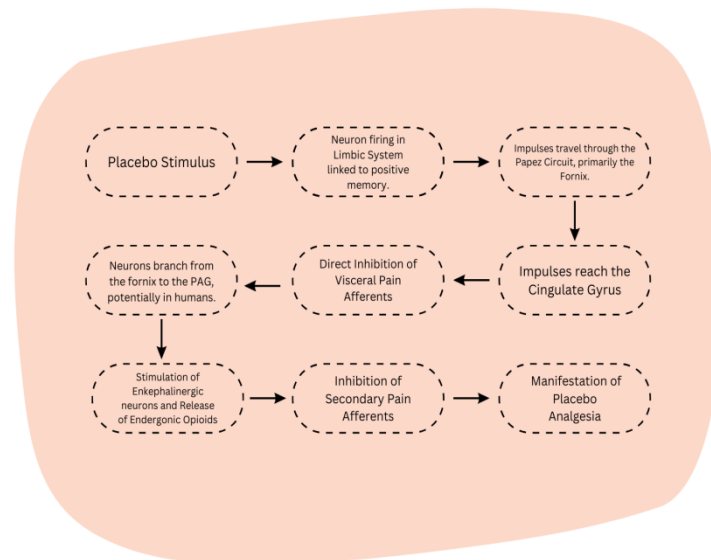


Figure 2: Parts of Human Brain and Psychological Response (Source: JourneyPure, journeypure.com/ask-our-doctors/)

«One of the important functions of this region (PAG) is that it produces endogenous opioid like enkephalin. Such endogenous opioids are known to inhibit the pain afferent signals at the level of secondary neurons of the antero-lateral pain pathway. Studies have found that when opioid inhibitors (naloxone) were given to the patients receiving a placebo, they showed no response to the placebo. So, the opioid system is the system causing placebo reliefs (Levine et al. 1978).»

However, in the biological system of human beings, the opioid release mechanism is not yet completely deciphered. The opioid system could be activated by some fibres which possibly connect the hippocampus to the PAG of the mid-brain through the Papez circuit. And the endogenous opioids released from there could cause the placebo response. If so, then the mechanism of placebo initiation can so far be mapped as:



«As shown above, placebo response is the feature of our subconscious mind. It bypasses our intelligence system (the neo-cortex) and acts through the pathways of emotional processing which activates the release of certain chemicals which, in turn, brings relief.»

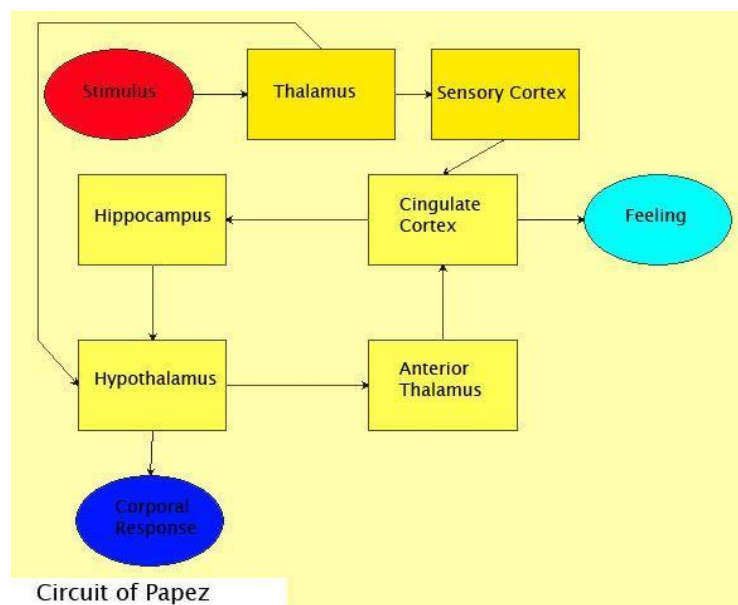


Figure 3: Papez Circuit (Source: Wikimedia Commons under fair use policy)

STIMULUS OF PLACEBO RESPONSE AND THE ROLE OF MIRROR NEURONS

Mirror neurons are defined by the property that they fire both during the execution as well as during the observation of a specific action. Rizzolatti et al. (2004) reported such types of

neurons in certain areas of the brain of macaque monkeys and found indirect evidence of neurons showing the same characteristics in certain homologous areas of the human brain.

There is direct evidence regarding the existence of mirror neurons in the brain of macaque monkeys. When the brain neurons of monkeys were recorded during tests involving action observation and execution tasks, certain areas in the frontal lobe (F4, F5 of monkey), inferior parietal lobule (area PF and PFG) and primary motor cortex fired during both observation and execution of the action (Rizzolatti et al. 2004).

Later on, by performing various brain imaging experiments, it was found that certain region of human brain showed similar properties of firing when action observation and execution was performed, although in variable ratio across different regions in the brain. Interestingly, these regions in human brains were homologous to those areas of the monkey brain where mirror neurons were found (Rizzolatti et al. 2004). This provided indirect evidence of the presence of mirror neurons or more accurately the presence of certain neurons which showed mirror activity in the human brain.

This is a significant discovery that can lead to better understanding of the human mind-body system.

IMPLICATIONS OF DISCOVERY OF MIRROR NEURONS IN HUMAN BRAIN

Mirror neurons, in simple words, are the neurons that act like a mirror, i.e., they reflect a particular action observed by an individual into his own motor repertoire. Depending upon the accuracy, they can be subclassified into strictly congruent and broadly congruent mirror neurons (Rizzolatti et al., 2004). We already know that mirror neurons have a chief role in the process of action imitation. But the same study has also reported that mirror neurons are not just involved in action imitation but also involved in understanding the action.

As mentioned earlier, the mirror neurons in monkeys were predominantly found in areas F4, F5 of the frontal lobe; areas PF, PFG of the parietal lobe and the STS (cortex of the superior temporal sulcus). Mirror neurons link these areas with the others and within themselves forming a fronto-parietal circuit that fires especially during action imitation. The PF receives the input from STS and transmits it to the F5 which is the pre-motor region in monkeys (Rizzolatti et al., 2004).

When we draw a correlation of the mirror neuron areas of monkeys with their homologues in humans, we find that area F4 represents the ventral premotor area (corresponding to Brodmann's Area-6), F5 lies in the posterior part of the pre-motor area (Brodmann's Area-44), STS includes Brodmann's area 22. The area PF is Brodmann's Area 40 and Area PFG corresponds to Brodmann's Area 39. Mukamel et al. (2010) reported that in addition to the

human brain areas corresponding to their monkey mirror area homologues, there were mirror neuron activities in the following areas of the medial side of the frontal and temporal cortices. These areas are entorhinal cortex, hippocampus, para-hippocampal gyrus and the supplementary motor area. Further, few minor impulses, which ultimately confirm mirror-like activities, were also recorded from the adjacent areas like anterior cingulate gyrus, amygdala and hippocampus.

So far, we have gathered information that humans do have mirror neurons and have translated them in terms of Brodmann's areas which are much widely used references in academia. The areas having mirror activities are Brodmann's area 6, 44,22,40,39 and from the medial side of the cortex, they are Brodmann's area 34 & 28 (entorhinal cortex), 28 & 35(hippocampus), 27 & 36 (para-hippocampal Gyrus).

Learning is a process where a repeated sensory stimulus leads to the formation of new neuronal circuits in the regions of the hippocampal and para-hippocampal gyrus. Later on, even a small fraction of that stimulus, given in a correct situation, may lead to the spontaneous recall of the episodic memory giving rise to specific motor output. At this point, it is crucial to know that the autonomic nervous system of the body is also a part of the motor system and the endogenous opioid activity of the mid-brain is an autonomic process of human body.

Mirror neurons are connected to each other, forming a circuit, and cooperatively add to the process of learning and memory retention of the learned action. In this way, mirror neurons are linked to a process called Hebbian Learning (Mukamel et al. 2010)

UNDERSTANDING THE FOUNDATION OF YOGA USING THE ABOVE CONCEPTS

In our quest to understand the pathway of yogic philosophy we can focus on the mirror activities of the medial frontal and temporal lobe and its association with the formation of memory and emotions.

Patanjali Yoga Sutra mentions samyama (combined simultaneous practise of dharana/concentration, dhyana/meditation and samadhi/union) as a tool to achieve deeper knowledge of qualities of an object. It is a term summarising the comprehensive process of psychological absorption in the object of meditation/yoga. The Sutra then describes various psychic experiences (siddhis) that the yoga practitioner may experience through the conduit of samyama. As an example, when a yogi does contemplative meditation on elephants, he gets the power of elephants.

The significant point to be appreciated while considering this in a logical framework is that we can draw a strong analogy between transfer of characteristics to the meditator practicing contemplative meditation (samyama) and between pain relief in the placebo-responder.

This framework can be described as follows. When a person observes a siddha yogi (an accomplished yoga practitioner with psychic abilities), his initial efforts to learn the process comes from the activity of imitation and understanding of the moves by the mirror neurons located at the lateral aspects of the brain. A few repetitions of this process initiates Hebbian Learning and more mirror neurons are activated and their circuits are generated in the limbic mirror neuron areas and the areas on the lateral side of the forebrain (Mukamel et al., 2010). Regular practise enables the person to comprehend the moves just by some audio-visual hints since more mirror neurons are added to the medial areas of the brain and a circuit is established within the local area and the surrounding lobes of the brain leading to the formation of long-lasting memory of the action. Gradually, when connections are established with the cingulate gyrus, a particular emotion also gets associated with that memory. In other words, the addition of mirror activity in these areas of the brain lead to the powerful association of permanent memory and emotions related to the yogic method. And during the demand of the situation, spontaneous recall of that memory will lead to the execution of the motor activity corresponding to the psychic ability (siddhi) that he had been practising.

CONCLUSION

Repeated stimulation of the mirror neurons consistently add more and more mirror neurons which lead to the intensive formation of the neuronal circuit. Ultimately, this results in the individual being immensely capable of initiating the desired mechanism spontaneously. We can, therefore, conclude that regular and dedicated practise of appropriate yogic techniques can help improve the overall well-being of the individual. Understanding and applying these methods can bring a significant amount of change in the type of medicine we practice today and can be helpful in creating a holistic healthcare system for the public.

Brief Profile of the Authors:

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Statements and Declaration: A simplified version of this article, written by the same authors, has been published as a non-academic article in www.scimonk.com. The common sections between the two write ups, which constitute about one-third of this paper, are included within the quotation marks « and ».

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Glossary of Medical Terms Used:

« *Analgesia*: The phenomenon of relief from pain.

Autonomic Nervous System: Part of the peripheral nervous system that regulates involuntary physiological functions, including heart rate, blood pressure, digestion, and respiratory rate.

Cerebral-Cortex: Outermost part of brain or Neo-cortex composed of Gray Matter (Neuron Bodies).

Cerebrospinal fluid: CSF is the fluid that flows within the ventricles of the brain and provides nutrition to it.

Cingulum: Part of the Cerebral Cortex situated on the medial aspect, part of the Limbic System

Endogenous Opioids: Organic compounds produced by our body that resemble the structure of the opium poppy extracts.

Enkephalinergic: Neurons that release Enkephalin (Endogenous Opioid).

Fornix: A bundle of White Fibres of the brain (Nerve) forming a part of the Papez Circuit.

Hippocampus: A structure of the Limbic system, concerned with memory and emotions.

Limbic Lobe: Part of the CNS situated medially in the Brain, deals with emotional processing.

Mirror Neurons: They are found in the premotor cortex, the supplementary motor area, the primary somatosensory cortex, and the inferior parietal cortex. Mirror Neurons are responsible for the learning process.

Motor Functions: Ability to contract a muscle.

Neo-Cortex: The Telencephalon of the Brain, which is newly developed in humans during Evolution.

Papez Circuit: A circuit of neurons connecting through The Fornix, The Hippocampus, the Hypothalamus, Mammillary Bodies, Anterior Thalamic Nuclei and the Cingulum.

Para-hippocampal: Part of the Cortex around the Hippocampus. Part of the Limbic System.

Peri-aqueductal Gray (PAG): Collection of neuron cell bodies, around the cerebral aqueduct (a central canal of the midbrain containing cerebrospinal fluid).

Somatic Function: Ability to consciously perceive or influence a certain activity of the body.»

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