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Niraj Nayan Rishi *

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Review Article

Bridging the Science Between Yogic Postures (Asanas) and Neurophysiology: A Narrative Review

Niraj Nayan Rishi [1]*, Sunil Singh Yadav [2], Sneha Bharti [1], Sangeeth Somanadhapai [2]

[1]Maharishi Aurobindo Subharti College and Hospital of Naturopathy & Yogic Sciences, Swami Vivekanand Subharti University, Meerut, India.

[2]Faculty of Naturopathy & Yogic sciences, SGT University, Gurugram, Haryana, India.

***Corresponding Author:** Niraj Nayan Rishi, Maharishi Aurobindo Subharti College and Hospital of Naturopathy & Yogic Sciences, Swami Vivekanand Subharti University, Meerut, India.

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Abstract

The two main components of yoga practice, asana (posture) and pranayama (breathing practices), are well-known. The spatial alignment of a body is referred to as its "posture". Yogi Maharishi Patanjali clarifies that the posture needs to be stable and at ease. Numerous studies have documented the health benefits of asana, such as preserving the equilibrium between the autonomic nervous system and the endocrine system, normalizing blood pressure and glucose levels, enhances memory concentration, and preserves physical health. The alterations in the thalamus, cerebrum, first-order, second-order, and third-order neurons, among other brain regions, are not thoroughly described in scientific literature. In this review paper, we examine how the asana affects conscious proprioception, which in turn stimulates the thalamus via the medial lemniscus route by sending a signal to the gracile fasciculus and cuneate fasciculus via the posterior nerve root ganglion. This activates the premotor cortex of the cerebrum's Brodmann areas 3b, 1, and 2, as well as the postcentral gyrus and the somatosensory cortex. Working on the Vijnanamaya Kosha (intellectual sheath), the prefrontal cortex, also referred to as the sheath of intelligence, has direct connections with the premotor cortex. This improves various aspects of health. For doctors, researchers, experimental researchers, and anyone interested in utilizing the neurological advantages of yoga, this paper will offer a comprehensive overview of the neuropsychological mechanisms involved in asana practice.

Keywords: yoga; asanas; neurophysiology; prefrontal cortex; panchakoshas

1.Introduction

The aim of yoga, an ancient discipline of mind-body techniques, is to achieve balance in one's physical, mental, emotional, and spiritual well-being. Most people consider yoga to be a combination of Asana (physical poses) and Pranayama (breathing exercises) [1].

The spatial alignment of a body is referred to as its "posture". It helps maintain balance throughout both static and dynamic movement by giving information about the body's position in space. Numerous factors, including neurophysiologic, biomechanical, and psychological elements pertaining to the evolutionary history of the species, impact posture.

A person's natural, unconscious posture is how their body responds to gravity. The human body works in tandem with the centre of gravity to adjust posture and maintain proper alignment. Many factors come together to preserve equilibrium and the body's centre of gravity. Including the base of support (BOS), centre of support (COS), height of centre of gravity (COG), line of gravity (LOG), body weight, and base direction relative to the force acting on them. These continuously adjusted by the neuromuscular system and musculoskeletal system, which includes skeletal muscles, bones, and joints, contracting in response to various stimuli [2,3].

In addition to proprioceptors, ocular, vestibular, and somato-sensorial (tactile) pathways also regulate posture [4]. Proprioceptors' primary function is to continuously and precisely give information on the location of limbs and other body parts in space. This type of sensory data is provided by low-threshold mechanoreceptors, which are necessary for the accurate performance of intricate movements. Examples of these mechanoreceptors include muscle spindles, Golgi tendon organs, and joint receptors. Particularly crucial information relates to head and movement positions. Proprioceptors are included into an extremely specialized vestibular and visual systems in this context [5]. The visual system receives information from the surroundings "through the retina," the cutaneous system "through the receptors under the feet," the vestibular system, and additional sensory systems such as muscle spindles and Golgi tendon organs.

2. Yogic Practices (Asanas)

Maharishi Patanjali explains that the shloka number (PYS-2.46) denotes "Sthira Sukham Asanam" which translates to a steady and comfortable position. One can consciously control their posture by repeatedly attempting to reach a final position or location in space, as stated in the shloka of (PYS-2.47) "Prayatna Shaithilya Anant Samapatibhyam." Another meaning expressed in the last shloka of (PYS-2.48) "Tato duanduanabhighatah" is that someone who has attained this state of self-realization does not experience duality (such as happiness and misery, failure and success, loss and gain, negative and positive, pleasure and suffering.[6]

Asana is referred to as the first element of hatha yoga, according to Hatha Yoga Pradipika (HYP 1.17), which also states that "HathasyaPrathmaangatvadasanampoorvauchhyatekuryatasanamSthairyamAragyam cha langhavam." Practice of asana leads to disease-free health, lightness (flexibility) of the limb, and and steadiness (firmness) of body and mind [7]. Therefore, the purpose of this review is to determine how the asanas described in the PYS and HYP relate to contemporary physics and how their neurophysiological mechanism helps to prevent and treat a variety of ailments

3. Neurophysiology of Yogic Asana (Physical Posture)

The body's trunk and lower limbs provide unconscious proprioceptive information to the cerebellum. The pseudounipolar neurons in the dorsal root of the ganglion receive all sensory data from the periphery. Impulses are sent to Clarke's nucleus in the posterior grey horn by the first-order neuron in the dorsal spinocerebellar tract, the posterior nerve root ganglion. This group of nuclei, known as Clarke's column, extends from C8 to L3 along the spinal cord.

The medial region of the spinal cord's lamina VII contains Clarke's column. The dorsal spinocerebellar tract ascends from Clarke's column at the side of the brainstem, passes through the inferior peduncle, and terminates as the majority of the cerebellar cortex fibers in the cerebellum. The information specifically travels to the anterior lobe of the cerebellum's vermis and paravermis. The cerebellum then uses its understanding of the lower limbs' and trunk's sense of position to construct and coordinate voluntary movement [8-10]. The signal is sent to the posterior gray horn's marginal nucleus by the first-order neuron, or posterior nerve root ganglion.

The ventral spinocerebellar tract, which parallels the dorsal spinocerebellar tract and similarly processes unconscious proprioceptive input, is formed by the neurons in the marginal nucleus following crossover. Through the superior peduncle, the ventral spinocerebellar tract ends in the cortex of the cerebellum's anterior lobe. Motor information is relayed via the ventral spinocerebellar tract (VSCT). Because of its many polysynaptic inputs and broad receptive fields, the ventral spinocerebellar tract appears to relay information regarding the state of muscle groups and the entire extremity. [10-12].

The ocular system, peripheral vestibular organs in the inner ear, and projections from the central nervous system comprise the vestibular system. One of the cerebellum's branches, the vestibulocerebellar, is believed to be crucial for maintaining eye control and postural reflexes as well as for sense of head motion and spatial orientation. [12-16].

Muscles are stretched by yoga poses. Different neurons receive a signal when a muscle is stretched. Sensory receptors called muscle spindle stretch receptors are located in the belly of modified muscles. They use sensory neurons to send information about variations in the length and tone of the active muscle to the central nervous system (CNS). In order to prevent overstretching or tearing, these spinal cord reflex arcs regulate muscular contraction by stimulating motor neurons through the stretch reflex, which instructs active muscles to contract and oppose such excessive muscle stretch [17]. The proprioceptor monitors the movements and alterations in the various body parts during the Asana. The first order neuron (posterior nerve root ganglion) receives the signal from these conscious proprioceptors. These are the nerve fibers that start on the side opposite the dominant hand and pass via the cuneate and gracile fasciculi, respectively, before entering the cuneate and gracile nuclei. The second order neurons then begin where the cuneate and gracile nuclei merge to generate internal arcuate fibers. A crossover event creates the medial lemniscus route, which connects to the thalamus's ventral posterolateral nucleus. The third order neuron that transmits the signal to the cerebrum's primary somatosensory cortex begins in the thalamus [8,12].

When a posture is easy to maintain, done mindfully, and has the power to alter the practitioner's mindset, it is said to an asana [7]. The practitioner of the asana must hold a particular posture with complete awareness for a predetermined amount of time [7]. Therefore, the signal transmission from Clarke's column or the marginal nucleus to the gracile fasciculus or cuneate fasciculus is shifted by the first order neuron (posterior nerve root ganglion). Rather than triggering the cerebellum, this engages the somatosensory cortex of the cerebrum through the Ventral Posterolateral nucleus of the thalamus [18,19]. The main brain region responsible for processing sensory data is the thalamus. All peripheral sensory impulses that arrive at the thalamus are combined and altered prior to being transmitted to particular regions of the cerebral cortex. The term "sensory information processing" is often used to describe this thalamic function.

The opposite side's sensations are produced by activation of the cerebrum's somatosensory cortex. The topological structure of this area is referred to as the sensory homunculus, or "little man" [20,21]. On the lateral surface of the front parietal lobe, caudal to the central sulcus, is the postcentral gyrus, which corresponds to Brodmann areas 3b, 1, and 2 [21,22]. The postcentral gyrus is also home to the secondary somatosensory cortex, which may be involved in the integration of somatosensory information and memory formation. It combines kinesthetic and cutaneous perception [21,23]. At the lip of the central sulcus, the primary somatosensory cortex plays a crucial role in the integration of motor and sensory information necessary for proficient movement as well as in the processing of afferent somatosensory input [23]. Areas 2 and 3 are in charge of integrating these experiences, while Area 1 is in charge of sensory perception. Through sensory feedback, this area sends the signal to the premotor area. The premotor area is made up of sections 6, 8, 44, and 45. The premotor area is situated ahead of the primary motor area in the postcentral cortex. Through the transmission of motor impulses to the axial muscles, this region regulates postural movements. Area 6 oversees the skilful movement of muscles that Area 4 begins. Area 8 is devoid of visual cues and is used for voluntary eye movement and scanning. The larynx, lips, and tongue are all moved in areas 44 and 45 [12]. The macaque linkages reveal a network of motor translator regions that project the premotor area straight to the prefrontal areas [24]. The prefrontal cortex is responsible for controlling behaviour, emotions, memory, learning, and judgment. The sheath of intelligence, which envelops an individual's personality, is another name for this region. Through the hypothalamus, it regulates the endocrine and autonomic nerve systems [12,25].

4. Discussion

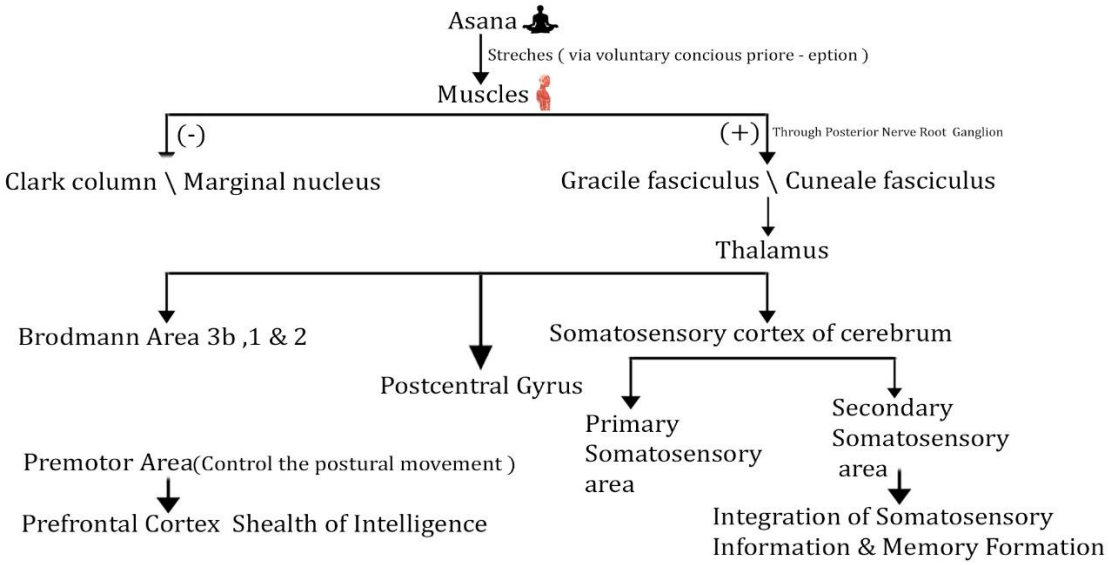
Yogic asana increases perception, memory, and mood by stimulating the alpha, beta, and theta waves [26]. Similar research revealed that yoga poses boost students' overall wellbeing and reduce anxiety [27]. Stretching and yoga poses enhance the quality of life, discomfort, and dysmenorrhea symptoms [28]. The same research described in this page explains how asanas activate the prefrontal contex, which regulates behaviour, emotions, learning, memory, and judgment.

Asana, a type of yoga, works on the HPA axis by decreasing the sympathetic nervous system and activating the parasympathetic nervous system [1]. This improves both physical and mental health.

Additionally, the prefrontal cortex influences mood by regulating mood-altering neurotransmitters such as serotonin, dopamine, and norepinephrine [25]. Maharshi Patanjali explains that asanas eliminate the dualities of the psyche, such as joy and sadness [29].

The Taittiriya Upanishad explains the Panchakosha, which is the fundamental part of the human body. The Annamaya Kosha (Physical body), Pranamaya Kosha (Energy body), Manomaya Kosha (Mind body), Vijnanamaya Kosha (Intuitive body), and Anadamaya Kosha (State of happiness) are the five components of Pancha Kosha (the five layers of human being). The sheath of intelligence is the subject of the Vijanamaya Kosha (Intuitive body) among the Panchakosha [30,31]. The term "sheath of intelligence" refers to the prefrontal region [12].

The numerous sickness symptoms are treated by the yoga pose, which also works on the Annamaya Kosha (Physical body). It is also referred to as the sheath of intellect, or the Vijyanamaya Kosha in yoga, and it stimulates the prefrontal cortex. Stress is the primary cause of all diseases. It starts with disturbances in the Manomaya Kosha (mind body), moves gradually to the Pranamaya Kosha (energy body), and eventually to the Annamaya Kosha (physical body). This causes non-communicable diseases to move more quickly from the psychic to the organic phases. Ashtanga Yoga, or the Eight Limbs of Yoga, is explained by Maharshi Patanjali as a way to activate the Vijyanamaya Kosha, or Intuitive body, which will balance all the Koshas [32]. One of the Ashtanga yoga's eight limbs, asana (physical posture), will address each of the koshas. (Figure 1)



5. Conclusion

Yoga poses (asanas) stimulate the prefrontal cortex through the thalamus and premotor region, thereby balancing the body's hypothalamic-pituitary-adrenal (HPA) axis and autonomic nervous system. This balance reduces stress, which in turn aids in healing diseases and enhancing emotional regulation, memory, judgment, and behavioural control. According to Maharshi Patanjali, the asanas work on all the Koshas, eliminating duality from the mind and allowing the practitioner to experience pleasure.

Research indicates that the practice of asanas not only improves physiological functions but also promotes psychological wellbeing, making it a comprehensive approach to holistic health.

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