Meditation Experiences, Self, and Boundaries of Consciousness

Abstract

Our experiences with the external world are possible mainly through vision, hearing, taste, touch, and smell providing us a sense of reality. How the brain is able to seamlessly integrate stimuli from our external and internal world into our sense of reality has yet to be adequately explained in the literature. We have previously proposed a three-dimensional unified model of consciousness that partly explains the dynamic mechanism. Here we further expand our model and include illustrations to provide a better conception of the ill-defined space within the self, providing insight into a unified mind-body concept. In this article, we propose that our senses "super-impose" on an existing dynamic space within us after a slight, imperceptible delay. The existing space includes the entire intrapersonal space and can also be called the "the body's internal 3D default space". We provide examples from meditation experiences to help explain how the sense of 'self' can be experienced through meditation practice associated with underlying physiological processes that take place through cardio-respiratory synchronization and coherence that is developed among areas of the brain. Meditation practice can help keep the body in a parasympathetic dominant state during meditation, allowing an experience of inner 'self'. Understanding this physical and functional space could help unlock the mysteries of the function of memory and cognition, allowing clinicians to better recognize and treat disorders of the mind by recommending proven techniques to reduce stress as an adjunct to medication treatment.

Keywords: Meditation; Transcendental consciousness; Default space

Review Article

Volume 4 Issue 1 - 2016

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Received: June 3, 2016 | **Published:** July 06, 2016

Abbreviations: PFC: Prefrontal Cortex; LGN: Lateral Geniculate Nucleus; ANS: Autonomic Nervous System; DPFC: Dorsolateral Prefrontal Cortex; TM: Transcendental Meditation; DMN: Default Mode Network; EEG: Electroencephalogram

Introduction

In philosophy and neuroscience alike, it is not understood how the brain functions to form the mind [1,2]. The brain is a physical organ that can be touched and tested, yet the mind is a substance that has no physical qualities that can be examined objectively. Although brain imaging can highlight physical aspects of the areas that function when completing tasks or during various conscious states, there are currently no viable tests that can look into the global inner complexities of the mind.

The mind is experienced subjectively but has proven difficult to explain objectively because we lack a definition that can do more than merely describe its function [3]. Consciousness and the mind are often used as synonyms, neglecting to connect the neurobiological aspects to *how* the physical elements that comprise the brain form the subjective and experiential "I" [3]. Current prevailing theories and concepts in neuroscience and philosophy consider consciousness to be separate from the body. This problem arose when Rene Descartes proposed in the 1600s [4] that the mind and body are two entities-independent from one another, a concept commonly referred to as Cartesian dualism [3,4,5]. Descartes proposed that the mind and body are incapable of existing in unison because the physical body could not 'think' but the immaterial mind can, thereby forcing a person to exist in two perspectives simultaneously-one physically in the body and one mentally in the mind [4].

Similar to Cartesian dualism, theories such as biological reductionism, physicalism or materialism, and the philosophy of mind [6] all consider the body as separate from the mind, defining the mind only as a function of the brain. These theories suggest one is at the mercy of what the brain believes to exist versus its interpretation of what it thinks exists, reducing the person to simply a giant brain with synapses which does the thinking, feeling, and decision making [6]. However, these theories fail to explain how the mind is capable of doubting the stimuli it receives from the body, searching for a truth or certainty, which is evidence of a thinking mind, independent from bodily stimuli received by the brain [5].

Current theories on consciousness lack explanation about how the brain functions as the mind. We propose that the mind and body function as one unified entity, based on the phenomenon of fast dynamic brain-body oscillations that impart a dual combined experience of 'Self' with external and internal space, thus allowing the mind and body the ability to think and act together as one unified being. This may be explained such that while in utero, a neural network was formed through retinal and brain oscillations which allowed the brain and retina to communicate as one entity [7-10]. This unified space is the 3D default space that allows us to experience an internal representation of the external environment. In the following sections we discuss the purpose of brain oscillations in consciousness, and further explain the formation of our previously proposed 3D default space theory, see [11].

Brain oscillations and the 3d default space

We consider brain oscillations dynamic because sensory and cortical information is organized around the thalamus which allows us to experience the external world. Alpha, gamma, retinogeniculo-cortical, and corticothalamic oscillations are essential in forming the 3D default space because they allow constant and continuous communication between the brain and the body-without them, we do not think that consciousness can emerge.

Alpha oscillations vibrate at 8-14 Hz, strongly influencing brain activity [12,13] are the dominant oscillations (at 10 Hz) [14]; 2) are fundamental in central nervous system functioning [15]; and 3) are more powerful when one is relaxed with closed eyes or in a dark environment [14,16]-which suggests is the constituent for visuospatial consciousness that is formed, giving us binocular vision [17].

Gamma-band oscillations vibrate at a frequency of 28-48 Hz [15], but those greater than 30 Hz are important for the neural coding during cognitive processes, and in the visual cortex they are associated with fixed patterns of eye movement [18]. Sustained visual stimulation induces gamma oscillations to be in the range of 50-70 Hz [19]. Furthermore, gamma oscillation synchronization is essential in many brain functions including: 1) cortico-cortical communication occurs at 30-100 Hz [13,15,20]; 2) neural integration for cognitive functioning [15]; and 3) visual information organization and analysis [18].

It is through these fast alpha and gamma oscillations that we suggest an 'internal' neural space is formed, providing an infrastructure for visual consciousness. Neuronal synchronization with the lateral geniculate nucleus (LGN) through oscillations at 60-120 Hz is indicated by oscillatory activity in the retina, LGN, and cortex [21,22], which allows the brain and retina to receive and process visual stimuli as one organ. These retinogeniculo-cortical oscillations assist in the formation of the dynamic template that reduces external space into our internal world space we call the 3D default space. These fast oscillations and the fast synchronization allows the external stimuli to be processed by the thalamus and projected back to the sensory organ that received the stimulus, giving us the impression of an immediate processing of the external world. This process, which is already in place when we are born, continues to mature as we gain understanding of the external world [7-10,23].

Oscillations connect the entire brain with sensory input, process the information, and 'feed' that information to the thalamus to allow the experience of consciousness. The mind-body space that we have termed the 3D default space, serves as a template for the external space through corticothalamic oscillations that actively links together the senses in order for us to experience them moment to moment, allowing us to respond to them through the cognitive and intuitive activity of the brain. The sensory information received from the eyes, ears, skin, and nose is perceived internally via corticothalamic feedback oscillations that are viewed from the inside, but perceived as outward experiences, allowing us to experience and interact with the world around us. This process integrates the external world within our mind-body space with our senses.

In the next section, we highlight the process of evoked potentials that show that the way we see light or hear sound is a few microseconds after the light waves and sound waves, respectively, are converted to neural signals.

A proposed theory of the formation of the 3d default space

The human body contains nearly 4 trillion cells electrically charged [24] and integrated via: 1) pre-existing oscillations formed in utero that continue to develop post-birth, [7-9,12,23]; and 2) retinal processes that are constantly oscillating with the cortex. Retinogeniculo-cortical oscillations, e.g., alpha at 8-14 Hz, beta at 15-30 Hz, gamma at 30-100 Hz, and high gamma at 60-200 Hz [12,13,15,20,25] are the constant and continuous communication between the retina and the brain, allowing images to be processed in the brain immediately upon entering the eyes, which we suggest create the final images we see as the world outside of us (the external world).

The thalamus acts as a central hub, 'senses' electrical activity from the brain [11], and 'sees/experiences' the external world from the inside out. Furthermore, this experience is from the perspective of a tiny microscope that has magnified the information. All the incoming information received from internal stimuli or external stimuli is structured and organized around the thalamus, is magnified, and defaults into the 3D default space, which allows us to experience external events taking place all around us in real-time. The thalamus integrates the cortical faculties with external sensory stimuli, helping to amplify and intensify the initial information to allow the senses to work at the periphery (e.g., photoreceptors for vision, organ of corti for hearing, skin for touch receptors, tongue for taste, and nose for smell), and ignoring the internal 3D default space-which doubles as a mirror of external space. The thalamus receives: 1) sensory information from the eyes, ears, and skin by way of cranial and peripheral nerves, and 2) visceral information via the autonomic nervous system (ANS) and brain stem. Sensory information is converted to electrical, neural, and chemical signals [26-31], in a matter of microseconds [32-40], supporting the theory that our internal and external view of the world is processed at different temporal rhythms. We propose that all of these integrated cells and retinogeniculo-cortical oscillations form a 3D default space around the thalamus, providing the brain and body a place to solidify all incoming information entering the brain (Figure 1).

The eyes contain approximately 100 million photoreceptors (rods and cones) [41], of which we suggest about half (~50 million) are dedicated to amplifying and intensifying light that enters the eye [42,43]. We see the external world through these ~50 million "tiny eyes". It is proposed that all the retinal photoreceptors are merged via various retinal layers, i.e. the inner and outer plexiform layers, and other neural cells such as the amacrine

Citation: Jerath R, Cearley SM, Barnes VA, Jensen M (2016) Meditation Experiences, Self, and Boundaries of Consciousness. Int J Complement Alt Med 4(1): 00105 DOI: 10.15406/ijcam.2016.04.00105

cells [44-48]. We see the magnified representation of the initial image from close proximity, not unlike seeing images through a microscope or pair of binoculars. This electrical magnified representation of the primary image is instantaneously processed via lateral inhibition, to impart what we perceive as the visual field within the length and breadth of the retina. This processed image is indistinguishable from what we call the external visual field and vision, and we suggest that this mechanism underlies the phenomena of after-images, color inversion, binocular image, and the appearance of a 3D image from a flat picture.

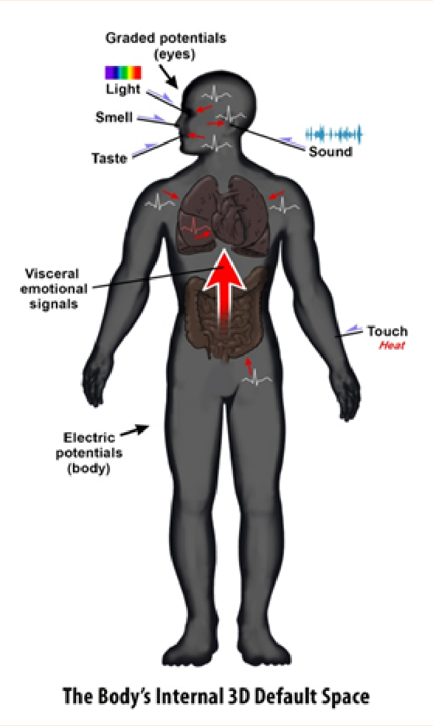

Figure 1: The Body's Internal 3D Default Space.

The internal 3D default space is the intrapersonal space that forms the 3D default space, forming the subconscious mind-body space. We are normally unaware of this 'dark' space, which is unequivocally "internal" because our brain can only perceive the neural signals from external and internal senses.

This internal 3D default space automatically orients us with time, space, and direction, allowing us to understand these elements. We unconsciously use this 3D default space to incorporate external stimuli with internal stimuli to experience the external world, allowing us to behave as one unified being.

Additionally when the eyes are closed, foveation further develops the 3D default space. The merged foveae, when viewed from the LGN level, carry a magnified view of both retinas [44], and this internal view of the retinal response serves as the internal visual fields within our internal visual consciousness [17]. This visual information is then received through the fovea and retina, processed through the corticothalamic feedback loops, and sent to the thalamus-which receives the information and its retinal integration via the corticothalamic feedback loops, inserting the information into the 3D default space so one can process and react to the visual stimuli we receive (Figure 2).

Some researchers in neurobiology broach the idea that the brain-mind-reality is inseparable because the brain is interconnected within itself. In addition, the brain is able to form a cohesive unity between it and the outside world through sensory input and nerve integration [49]. This supports our theory that the thalamus integrates information from the entire body and external environment to form a consciousness model that we have characterized as unified and three dimensional [17].

The 'self' and introspection

The 'self' has been described as a 'minimal self' and a 'narrative self', providing us a first person perspective and a third person perspective, respectively. First person perspective uses the 'I' pronoun, and is the source of thoughts, actions, and body ownership, while the third person perspective uses the 'Me' pronoun, linking together past, present, and future. If this narrative self is disrupted, amnesia occurs [1].

Although the scientific usage of introspection is controversial, it has been shown that neural activity related to introspection networks "obtain immediate information about processing in primary consciousness networks…" seen in "…sensory and motor events, as well as intention" [50]. However, it is argued that introspection does not make us aware of something we are not already aware of it only allows us to directly focus on something that peripherally we were already aware of [51]. Immanuel Kant said, "Introspection exhibits to consciousness even ourselves only as we appear to ourselves, not as we are in ourselves" [50]. Furthermore when one introspects, he/she only knows what it is like to be in that state for him/her, along with an awareness of the opportunity for introspection [51]. Some even gain the ability to tune into one's "self" through meditative practice, as discussed in the next section.

Experiencing the 'self' through meditation

Meditation techniques have been practiced for centuries due to the many benefits provided. Not only does meditation facilitate the ability to remain calm and in control of emotions during stressful situations, it also helps one to gain a better understanding of one's 'self' or presence in reality [52]. Meditation may be thought of as a voluntary practice altering state of mind in the direction of pure consciousness [53]. The process of meditation activates the brain's prefrontal cortex (PFC) increasing levels of free glutamate in the brain [50,54]. This stimulates the production of beta-endorphins which increases the levels of serotonin. Functional MRIs have identified regions of the brain that are activated during simple meditative practices (e.g., dorsolateral prefrontal cortex (DPFC), parietal cortex, hippocampus, temporal lobe, anterior cingulated, striatum, and pre-/post-central gyri) including default mode network (DMN) activity that is altered during meditation [55]. This has helped identify the activation of neural structures that are involved in attention and autonomic nervous system control [49].

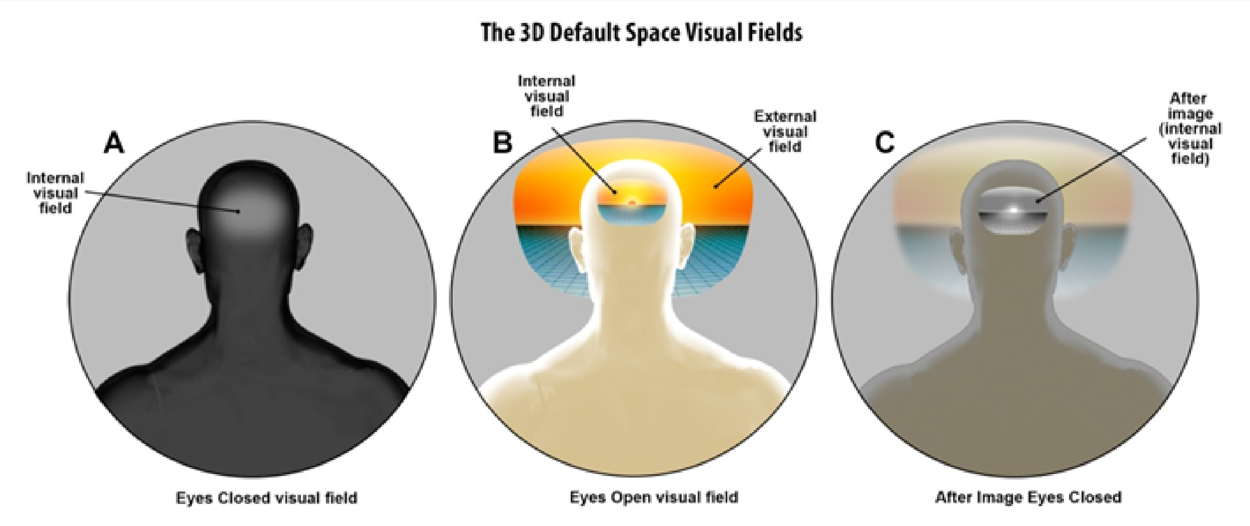

Figure 2: The 3D Default Space' and the Visual Fields.

Figure A: The body's intra-personal space, which appears dark and without and boarders from allocation when viewed internally with the eyes closed. The retinal, geniculate, and cortical pathways synchronize when the eyes are closed and integration of these pathways allows for an internal vision that forms a default template for external visual space within.

Figure B: Shows the seamless merging of binocular vision when viewed from behind the eyes at the level of the thalamus. It resembles the external visual fields in space when the eyes are opened, the external space with the objects are seen with the correct distances automatically in place.

Figure C: Shows the afterimage demonstrating that we carry the external world within our minds. When we see an image and close our eyes, we continue to see that image. But if we turn our heads, we see the image in the direction our head faces. However, when we open our eyes we realize the external image is not where we see the internal image because the external image did not move with us, only our internal image moved.

Attention, emotion, and imagery are created by hippocampal connections in the PFC, amygdala, and hypothalamus [56]. When the PFC is activated, increased levels of free glutamate signal the hypothalamus to release the neurotransmitter, beta-endorphin- known for attenuating fear and pain, and producing emotions of joy and euphoria [57]. When thoughts stimulate the amygdala, the amygdala stimulates the hypothalamus and the parasympathetic system [58]. Respiration and heart rate may slow down during meditation, inducing the feelings of calmness and relaxation, causing reduced locus coeruleus activity. This decreases hypothalamus stimulation, and decreases the hormonal activity associated with stress (e.g. corticotrophin-releasing hormone, adrenocorticotropic hormone, and cortisol) [48,56]. As a result, levels of arginine vasopressin are reduced, decreasing both peripheral vascular resistance and arterial blood pressure [58]. These physiological changes facilitate maintenance of positive feelings, "self-perceived arousal," and promote consolidation of new memories and learning [49].

Transcendental consciousness, or pure consciousness, the simplest form of awareness, is thought to be a 'self-referral' state, in which the observer is only aware of himself / herself and is not aware of any object or thought outside of the 'self' [59]. For practitioners of Transcendental Meditation (TM), this unbounded experience may become clearer with practice. Brain wave electroencephalogram (EEG) patterns that define experiences during TM-and the integration of such experiences with other consciousness states- have been found primarily in the frontal brain areas [60]. TM practice has been shown to decrease respiration rates and increase cardio-respiratory synchronization, resulting in the body's shift to a parasympathetic dominant state. This shift subsequently balances and regulates the activity between the autonomic nervous system and the amygdala [61]. Some meditation practices result in a passive relaxed state, and EEG measurements suggest that techniques such as 'mindfulness meditation' and open monitoring tend to produce an active relaxed state that is "associated with cognitive restructuring and learning" [62], but these states are markedly different from that of pure consciousness. Additionally, EEGs have shown that 'segmented breathing' and 'relaxation response' techniques can cause "high amplitude, low frequency" cardiorespiratory oscillations, resulting from "respiratory sinus arrhythmia" and an increased connection between heart rate and breathing. EEGs have shown that the 'breath of fire' technique that requires a moderate amount of conscious control, results in increased heart rate and decreases the connection between heart rate and breathing [63], that again are different experiences from pure consciousness. Zazen practitioners focus on attention on detachment from the thinking process to minimize thoughts, which has been shown to "enhance automatic memory, emotion processing, reduce conceptual thinking, and reduce judgmental self-referencing," along with "health, well-being and happiness"

[53,64].

The experience of pure consciousness [59] is identified as a fourth major state of consciousness [65]. Transcendental experiences have been reported during the practice of TM [60] such that the mind 'transcends' mental activity to experience the ground state of consciousness which is characterized by unbounded space and time. During TM, physiological changes have been shown to correspond with a least excited state of consciousness. This state can be experienced even by novice practitioners [1,65,66]. The TM technique is characterized by automatic self transcending and requires minimum cognitive control. The subject/object relationship is different in this state when compared to waking, sleeping, and dreaming, as the sense of personal 'self' is expanded with meditation practice [60] to an unbounded cosmic sense of 'Self'. Not only do these experiences last several seconds and occur spontaneously throughout the experience, they are also marked by: 1) slow inhalation, 2) autonomic orientation at the onset of breath changes, and 3) heightened alpha 1 (8-10 Hz) frontalcoherence [60]. It has been suggested that daily practice of TM promotes higher states of consciousness. These states are marked by the coexistence of alpha 1 EEG with delta EEG during deep sleep, higher brain integration, greater emotional stability, and decreased anxiety during challenging tasks [60].

During Tibetan Buddhist Meditation, a practitioner's experiences of mindful awareness of space could be the result from increased activity in the DLPFC and superior parietal lobe nexus [54]. Mindfulness meditation helps the practitioner to increase attention and memory functions, which allows the person to remember "experiences efficiently-without forgetfulness or distraction, and in the appropriate context," [67]. Skilled practitioners of mindfulness meditation have reported experiencing their body merge with time and space into a single, combined conscious experience. During TM, a skilled practitioner can seem to experience a lack of spatial borders and perception of time resulting in the experience of an infinite expansion of space [68]. With practice of mindfulness meditation, conscious controls involving self-referential processing bring about alterations in the sense of time and space, and are related to an altered sense of body [68].

Meditation and the 3D default space

These examples from various meditation experiences may help explain the 3D default space. Meditation practice can alter a person's state of consciousness and the DMN activity may change via PFC activation [54,49,53,55]. PFC activation affects attention, emotions, feelings of fear and pain, feelings of calmness and relaxation, hormonal activity, and physiological changes in blood pressure and vascular resistance because of: 1) increased levels of free glutamate and beta-endorphins, 2) cardio-respiratory synchronization, and 3) regulation of the central nervous system and amygdala, among others. The sensory organs convert external physical energy (i.e. light, sound, and temperature) and mechanical energy (e.g. touch) into electrochemical signals that are processed via the corticothalamic system, while integrating our emotions and feelings among our heart, lungs, and visceral organs with our limbic system. The state of the sympathetic dominant system or parasympathetic dominant system constantly influences our central nervous system in the 3D default space, as we experience changes in consciousness. Daily meditation sessions can culture the body toward a parasympathetic dominant state, allowing a person to be more in tune with their inner 'self'.

The 3D default space is the intrapersonal space which serves to form a concept of 'consciousness' [11], and may hold the secrets to all that we are. This interactive space is created by the fast oscillations that form the subconscious mind-body space that normally we do not consciously detect [69], but it is ready to interact with the external world at any moment to entertain the sensory information received through the sensory organs. The 3D default space provides the infrastructure for all senses, but even without sensory perceptions, oscillations still occur [69]. However, when the eyes are closed (Figure 2), this space is experienced internally as a transcendental and borderless space, being described as a deeply silent 'self-referral' state experienced in meditation [60]. The experience of transcendental consciousness, during meditation practice, is described as a state of inner wakefulness with no object of thought or perception, and is a step in the sequence of development of higher states [70]. Maintaining transcendental consciousness in activity as well as dreaming and sleeping, is thought to be indicative of 'cosmic consciousness' [71]. Alternating transcendental consciousness with the ordinary waking state refines and habituates the nervous system to maintain a 'cosmic consciousness'. With practice, one may develop the ability to spontaneously maintain transcendental consciousness at the deepest level of the mind, even while the mind is engaged in feeling and thinking activity [72].

Meditation has shown to be effective in stress reduction, anxiety reduction, increasing serotonin and melatonin, improving immune function, improvement in symptoms related to irritable bowel syndrome, and many other disorders including those related to stress [73-79]. Therein lies the importance of understanding this dynamic 3D default space-to understand how we can tap into its ability to control subconscious and unconscious aspects of our minds and possibly better treat mood disorders and stress-related disorders.

Evidence supports a model of higher consciousness that includes lucid dreaming, and 'witnessing' transcendental consciousness during both dreaming and deep sleep states [71]. An example is 'Cosmic Consciousness', an all encompassing awareness of Nature and the order of the universe, possessed by those who are 'enlightened'. We suggest that such higher states of consciousness are a natural development of long-term meditation practice facilitated by regular daily experience of transcendental consciousness. Self Consciousness, the awareness of being aware in the state of transcendental consciousness is central to the theory of higher states of consciousness and is the basis on which all higher stages of development take place [80]. The deep inward journey that takes place in transcendental consciousness may seem infinite, and meditators cannot see or feel borders during the 'self' experience. In the next section, we will further develop the theory that relates this experience to the visual and non-visual space processed by the thalamus.

Purpose of the 3D default space

The concept of consciousness suggests there is a relationship between the mind and the world. The phenomenon of consciousness is highly organized. It is where the brain and body interactions allow for precise communication between them to "condense" the external world into our awareness and perception. Our theory defines the internal 3D default space as material space, albeit abstruse within our brain and entire body, which houses our emotions, allowing them a place to develop and solidify. This space holds the secret to our internal universe. It is within this space that we become aware of both external sensory information (vision, sound, and touch), with internal sensory information (emotions and feelings), (Figure 1).

The sensory organs are in direct contact with the external world and information obtained from them enters via specific nerves and is processed via the corticothalamic system, resulting in magnification, amplification, and intensification of the primary stimulus at the sensory organs. Thus, we experience the external world through stimuli (internal and external) that is first processed through the cortex and projected into the thalamus through the corticothalamic feedback loops prior to conscious awareness [81,82]. This integrated combination of information from our mind and body forms a single, unified entity termed the 3D default space, (Figure 1).

The framework for this space is created through: 1) integration of layers of neural activity from the unconscious, subconscious, and conscious [69], and reciprocal communication between the heart and brain [83]. The unconscious perception of communication between the heart and brain is known as intuition [83,84]. Evidence suggests that the heart receives information before the brain does, yet we are unaware of the receiving, processing, and decoding of information [49,84] because it occurs within a fraction of a second. When two events occur less than 40 milliseconds apart, they appear as occurring simultaneously because we cannot detect time intervals less than 40 milliseconds [85]. This demonstrates that what we think we see around us is not the actual external world, but rather a re-creation of it within our minds [11], and substantiates our suggestion that our view of the external world is a recreation. We suggest this is an indication that the external space defaults into internal cognition, unifying them in the 3D default space [11].

Furthermore, the 3D default space has its own influence, and the corticothalamic synchronization gives the final feedback projecting the final information into the 3D default space [11,69]. Neuroscience associates feelings primarily with the orbital cortex and the amygdala as the emotional center of the brain [85,86], but further research has shown that the cardio-respiratory evoked potentials are also part of those emotions, often creating them [83,88-90]. This suggests that although the brain, heart, and lungs are separate organs they communicate through oscillations and the nervous system. We define various aspects of this 3D default space as having visual and non-visual components, and spatial coordinates such as anterior, posterior, lateral, superior, and inferior. We suggest that all cells of the body and their integration by the central nervous system helps unify the mind and body through cardio respiratory oscillations [69], into a space that integrates this information for perception as consciousness.

The cellular anatomic events form a peripheral aspect that synchronizes with its counterpart within the central nervous system. The micro and macro levels of organization are important for continued study because we suggest that at the macro level, the body's ~4 trillion cells behave as the "I". The sensory stimulus originating at the eye is magnified via corticothalamic feedback loops then back to the level of the retina and eye (as is with the ears for sound and skin for touch). We propose that from the central thalamic level all external senses directly percept the external space, allowing us to function as a unified person separate from our relationship to the external world, while internally being provided an internal view from the thalamus that orients us with an external mirage of what is happening internally.

Although we are unaware of the 3D default space, we unconsciously use it to incorporate information from the external world and information from within our body to experience the external world. Since visceral organs continuously transmit afferent neural signals to the brain, it is possible for a person to become consciously aware of the processes taking place within their body [91]. Those who have interoceptive awareness can perceive sensations from within the body to understand their own feelings and emotions [92]. The 3D default space can be thought of as a large, interconnected, intra-personal space that internally appears as "one" during introspection. Sensory impulses and internal visceral sensory impulses are processed in parallel by the brain in one large default space; however, we perceive these signals distinctly separate from each other.

Memory Space

Some findings suggest that the hippocampus, cortex, and thalamus are significant areas of the brain for memory [93-98], while other research suggests the role of the hippocampus in working memory is controversial [99,100], or that the hippocampus is involved in the creation of the memory space, spatial maps, and navigation [97]. We suggest that the 3D default space is pre-existing and is represented by all the cells in the body. This space includes the anterior, posterior, lateral, superior, and inferior parts of our intra-personal space as it relates to the thalamus, and this infrastructure is mapped by the networking of the hippocampus and parietal lobes, both of which are essential parts of the default memory correlates. We do not see the external space directly because it defaults into internal space to form memory space. The cortico-thalamic oscillations convert anatomy into functional memory space; therefore, we suggest that the 3D default space becomes the memory space within us that integrates internal and external stimuli so that sensory information can rise to consciousness, allowing us to be consciously aware of what our senses communicate with us about the external environment.

We suggest that activity of the brain is geared toward the 3D default space, as the seat of memory. For visual space, it involves the retina, thalamus, and cortex, and for the rest of the non-visual space involves auditory perception and parietal cortices, along with the skin, muscles, and other contents of the intra-personal space, which is evident in patients with contralateral neglect and phantom limb syndrome. The recognition and application of the 3D default space in basic clinical sciences and study of the 'self' because it may help explain how we reflect and understand our external environment.

Clinical applications arising from our understanding of the 3D default space

Understanding how the brain works as the mind can help

Citation: Jerath R, Cearley SM, Barnes VA, Jensen M (2016) Meditation Experiences, Self, and Boundaries of Consciousness. Int J Complement Alt Med 4(1): 00105 DOI: 10.15406/ijcam.2016.04.00105

with many disorders, many of which are beyond the scope of this article. However, we can utilize the concepts of generalized anxiety disorder, contralateral neglect, and phantom limb syndrome to explain how important the 3D default space is in our everyday lives.

Stress management via meditation has shown to be effective in treating anxiety a post traumatic stress [101-105]. Visits to primary care providers related to stress account for 60–80% of visits, yet few stress-related visits are accompanied by stress management counseling [106]. During 2006-2009 out of 33,045 physician office visits, stress management counseling was the least common type of counseling accounting for only 3% of the patients. Research has shown that stress can negatively affect health but cardio-respiratory synchronization via alternate nostril breathing techniques such as Pranayama [107,61] and meditation practice can help attenuate some of these symptoms associated with stress-related disorders and anxiety [108-110] due to the shift from a sympathetic state to a parasympathetic state [56,111].

Contralateral neglect syndrome and phantom limb syndrome are two examples that explain how we reflect and understand our external environment from an internal point of view. These disorders explain how internal damage to the brain can alter external perception, but external damage to the body only affects internal perception, respectively. This is supported by evidence that suggests that we do not need to have a sensory experience in order to have spatial orientation and memory, because the pre-existing oscillations in the hippocampus synchronize with the cortex and thalamus to generate spatial orientation without sensory cues [112]. Contralateral neglect and phantom limb syndrome are disorders that substantiate our main argument that we experience the external environment based on internal cues and perception. For example, cortico-thalamic activity linking all the senses together leads to specific memory that can be compromised by lesions in the right parietal cortex, leading to contralateral neglect, causing a person to be unable to process visual or somatic information relating to the left side of the body, including memories of that side [57]. The second disorder results from the loss of a limb and is known as phantom limb syndrome. Phantom limb syndrome results from sensory information still being active in the brain region associated with the missing limb, and when the eyes are closed, the mind still sees and feels the limb because the sensory neurons in the brain are still intact and sending signals, but when the eyes open, they see the limb is absent, resulting in the conflicting sensory information [113]. Both disorders are discussed next.

In contralateral neglect, damage to the right parietal lobe can affect the brain's ability to process any information received from the left side of the body, including visual or somatic input [57]. Since the parietal lobe is responsible for spatial mapping, the information from the corticothalamic feedback loops is unable to reach the thalamus, preventing visual information from being spatially mapped. When the connection between the cortex and thalamus is lost in this manner, visual and somatic information from the left side are unable to reach the thalamus, and unable to enter into the 3D default space. As a result, a person with this disorder is unable to perceive any visual or somatic information of the left side of the body, including access to any memories involving the left side. This lack of perception also prevents a person from recognizing their left limb as their own, or from being able to correctly draw a completed picture, because they do not see the left side of objects [57].

Pain in an amputated limb is known as phantom limb syndrome. Since the thalamus has an internal picture of our body and all of its parts, the amputation of a limb only removes the physical limb, but the sensory connections in the brain devoted to the limb are unaffected, resulting in conflicting visual and sensory information being sent to the thalamus [57,113]. The 3D default space contains the memory of the limb, along with the sensations even though the eyes can see that the limb is no longer a part of the body. This causes confusion resulting in pain or sensations. The eyes no longer see the limb, but the sensory connections are still intact and continue processing sensory information through the corticothalamic feedback loops, ergo the cause of the pain [113].

Since the 3D default space within us is a proxy for the world outside, it unconsciously interacts with the contents of the external world, i.e. objects, color, music, touch, and smell without the awareness of the 'inner self'. We suggest that this is why neuroscientists and consciousness theorists are unable to distinguish the boundaries of where our bodies end and the external space begins. This concept is apparent in clinical syndromes such as phantom limb syndrome, and contralateral neglect [17,113].

Workings of the 3D default space include the subconscious, unconscious, and conscious aspects of the mind, but the interaction among the three has not been fully explored. Controlled clinical trials conducted on respiration, respiration frequency, and respiration depth provides evidence that meditation can shift the autonomic nervous system from a parasympathetic dominant state to a sympathetic dominant state [114]. This provides a rationale for guided stress-management techniques, such as meditation, as options of treatment.

Conclusion

In this article we have illustrated that, apart from brain activity, executive attention, and corticothalamic functions, the experience of consciousness can be partly defined by a continual awareness of our environment and the continued interconnectedness of arousal, awareness, and attention to stimuli [49]. We have proposed that the 3D default space is normally undetected by us, and forms the subconscious mind-body space. This space is unequivocally internal, as opposed to external, because the brain perceives the neural signals from external and internal senses-not from external stimuli directly [31,82,115-117]. We suggest that the internal 3D default space exists for everyone-regardless of vision or hearing capabilities-automatically orienting us with time, space, and direction. This gives us the ability to understand those elements, and to behave as one unified being because sensory organs allow us to respond to external stimuli in a parallel fashion.

A major constituent for our theory is the interaction among the thalamus, cortex, and periphery in one space-the 3D default space. Although there are currently no empirical tests to prove our theory,

Citation: Jerath R, Cearley SM, Barnes VA, Jensen M (2016) Meditation Experiences, Self, and Boundaries of Consciousness. Int J Complement Alt Med 4(1): 00105 DOI: 10.15406/ijcam.2016.04.00105

we use examples from anxiety, contralateral neglect, and phantom limb syndrome to provide real evidence of this vital presence. The thalamus and corticothalamic feedback loops coordinate and integrate all stimuli we are internally and externally bombarded with, integrating it into the 3D default space moment by moment, in order for us to react to our external environment. Further, it is only aware of the external senses, not of the coordination that must take place before it rises to consciousness. Once this information has risen to conscious awareness, it becomes the 'I'.

Ultimately, the greatest benefit of practice of techniques such as pranayama and meditation, would be development of higher levels of consciousness such that having neutralized stress, one achieves a stress-free mode of functioning which is capable of spontaneously maintaining transcendental consciousness in a permanent state of cosmic consciousness.

Conflicts of Interest

All the authors declare that there were no actual or personal conflicts of interest, including financial, personal, or other relationships, people, or organizations that would influence or be perceived to influence their work while writing this manuscript. All pictures in this article are the original work of the medical artist, and all proposed theories are the original ideas of the authors.

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