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Review Article

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Neuroscience of the yogic theory of consciousness

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Abstract

Yoga as a practice and philosophy of life has been followed for more than 4500 years with known evidence of yogic practices in the Indus Valley Civilization. The last few decades have seen a resurgence in the utility of yoga and meditation as a practice with growing scientific evidence behind it. Significant scientific literature has been published, illustrating the benefits of yogic practices including 'asana', 'pranayama' and 'dhyana' on mental and physical well-being. Electrophysiological and recent functional magnetic resonance imaging (fMRI) studies have found explicit neural signatures for yogic practices. In this article, we present a review of the philosophy of yoga, based on the dualistic 'Sankhya' school, as applied to consciousness summarized by Patanjali in his yoga sutras followed by a discussion on the five 'vritti' (modulations of mind), the practice of 'pratyahara', 'dharana', 'dhyana', different states of 'samadhi', and 'samapatti'. We formulate the yogic theory of consciousness (YTC), a cohesive theory that can model both external modulations and internal states of the mind. We propose that attention, sleep and mind wandering should be understood as unique modulatory states of the mind. YTC allows us to model the external states, internal states of meditation, 'samadhi' and even the disorders of consciousness. Furthermore, we list some testable neuroscientific hypotheses that could be answered using YTC and analyse the benefits, outcomes and possible limitations.

Keywords: consciousness; theory; states of mind; modulations; attention; memory; mind wandering; yoga sutras

Introduction

The quest to understand consciousness has been an old one. Questions about our existence, 'Who am I?', 'What is the world?' and 'Why is there something rather than nothing?', have baffled philosophers for centuries. A plethora of philosophical systems were developed in India to answer these questions, which eventually condensed into six orthodox schools and at least four unorthodox schools (Box 1). Sankhya school dealt with the nature of reality broken down into its constituent parts (Box 2). Yoga emerged as a more practical philosophy to realize the true reality and has been practised since the Indus Valley Civilization. The philosophy matured for a few 1000 years when the rules and principles were compiled into the brief sutras by Patanjali (Box 3).

Consciousness as a field of study gained momentum in the Western world when Descartes described the mind–body problem and stated the popular statement, 'I think therefore I am'. The development of electroencephalogram (EEG) and other medical devices made it possible to record people when they apparently lost consciousness either during sleep (Borbély *et al.* 1981) or altered their states during anaesthesia (Akeju *et al.* 2016) or meditation (Travis and Keith Wallace 1999; Baijal and Srinivasan 2010). Crick and Koch stimulated an interest in the field with their works (Crick and Koch 1990, 2003).

The recent development of neuroimaging and stimulation modalities like fMRI, transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) increased the quest to understand our different states of consciousness, and many theories have been developed to allow for better experiments including integrated information theory (IIT) (Tononi *et al.* 2016), higher-order theories (Lau and Rosenthal 2011), global workspace theory (Dehaene and Changeux 2011), and recent ones like attention schema theory (AST) (Graziano 2020) and dendritic integration theory (Aru *et al.* 2020; Bachmann *et al.* 2020). Although the

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current theories offer many explanations for the different day-to-day experiences, they do not discuss or explain away the internal states as experienced during meditation, samadhi or even sleep.

The current theories tackle the question of consciousness as that associated with qualia or experience and try to answer the questions of the kind, 'What is it like?'. According to yogic thought, consciousness is not just the experience but a fundamental aspect of nature that enables the experience of a being. We formulate a theory called the yogic theory of consciousness (YTC), which is based on sankhya and yoga philosophy. There have been attempts to utilize the postulates of yoga to explain meditation (Awasthi 2013; Nash *et al.* 2013; Aravinda Prabhu and Bhat 2013; Bærentsen 2015; Raffone *et al.* 2019), which are not applied to the study of consciousness. Other studies have looked at meditation and consciousness (Raffone and Srinivasan 2010; Manuello *et al.* 2016) but were limited to Buddhist traditions and conceptions. Instead of taking the materialistic emergent approach to mind, consciousness and intelligence, sankhya takes a comprehensive approach to the description of the world. Sankhya postulates that the reality is composed of consciousness ('Purusha'), also called seer, soul, brahman, etc., and nature ('Prakriti'). The approach is convergent to what some philosophers suggest consciousness being a fundamental property (Kastrup 2018) which forms the basis of experience and it can not be explained as an emergent property of matter (Chalmers 1995).

YTC proposes that mind and seer are separate entities. The mind is emergent in nature, and it depends upon the number and type of sensory data streams an organism can receive (sense organs) and the number of ways it can act (action organs). Tanmatras or the sensitivity and sensory specificity of sense organs separate the individuals within species and across species to have a different percept of the world. The consciousness of an organism includes the role of the sense organs, action organs, mind along with intellect, ego and memory systems which represent the internal faculties, and the seer which is the seat of awareness. YTC can be generically applied to different animals as recent studies have demonstrated that a wide variety of animals including corvids display consciousness (Nieder *et al.* 2020; Birch *et al.* 2020).

YTC includes the concept of modulations of mind like sleep, memory, mind wandering, perception and inference, which suggests that the mind is aligned with the seer unless the mind is in one of these modulations. Meditation and finer states like 'samadhi' can occur when the mind reins in the modulations and becomes aware of the seer. Being established in the seer consciousness has been the goal for self-realization according to the yogic texts.

In this paper, we first introduce the organization of consciousness utilizing the sankhya–yoga philosophies in our YTC model followed by a discussion on the modulations of mind and how activity and connectivity of systems of the YTC model could result in these modulations. We then describe various internal states as experienced during yoga and the finer states of 'samadhi' with an explanation of how they can be modelled using YTC and propose some experiments to test such states. We discuss how YTC can explain various disorders of consciousness. We end by listing some predictions we can make using the YTC model and the description of modulations, internal states and finer states. YTC is one of the first theories of consciousness that integrate both internal and external states and can provide testable predictions and experiments to establish these results.

Box 1: Indian philosophical systems

Indian philosophical system starting with the Vedas illumined in various Upanishads became concentrated in six major schools not necessarily independent of each other. Indian thought was divided into six schools of philosophy—'Nyaya', 'Vaisheshika', 'Sankhya', 'Yoga', 'Mimansa' and 'Vedanta', which highlighted various aspects of reality and the association of living beings with that reality. Other schools of philosophy also emerged in India which did not consider the Vedas as a means of knowledge and were considered unorthodox schools including Buddhism, Jainism, 'Charvaka' and 'Ajivika'.

The 'Nyaya' school, one of the oldest schools of philosophy, emphasized the use of logic and reasoning to arrive at any conclusion about the world. The purpose of the senses was to gain knowledge of the world. 'Nyaya' school emphasized epistemology or the ways to acquire knowledge about the world. It relied on four out of the six means to gain knowledge (epistemes)—'Pramaana'/observation, 'Anumaana'/inference, 'Agama'/written testimony and 'Upamaana'/comparison and excluded derivation and negative proof.

'Vaisheshika' was expounded by Kanada, one of the earliest atomists. He explained the reality as having different types of 'padarathas'/categories by which any matter could be understood namely substance, quality, activity, commonness, particularity and connectedness. Kanada also integrates the concept of space, time and mind. 'Vaisheshika' also deals with the theories of motion, epistemology, ontology, the description of 'dharma', a case for 'atman' or soul, and discussions on enlightenment and 'moksha' (Kak 2016).

'Sankhya' school enumerated and categorized reality in its constituent parts. It was a dualistic school that emphasized that the unmanifest reality ('Purusha') interacts with the manifest reality ('Prakriti'), and upon its interaction forgets its true nature and believes that the purpose of the human existence is to realize the true nature of themselves, which is the 'Purusha' and not the creation ('Prakriti').

Yoga is the school of practice and illumines the way of realizing 'Purusha' being one with our true nature by slowly clearing away the seeds of identification with the 'Prakriti' through dedicated practice upon which the false association drops and one gets enlightened and realizes its true nature (Virupakshananda 1995; Shankar and Ravi 2010).

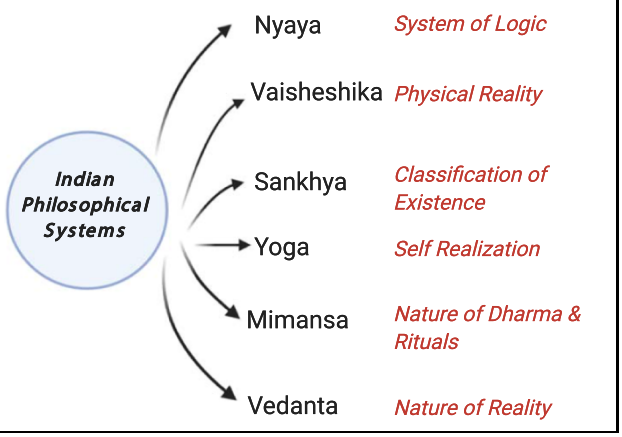
'Mimansa' school focused on the concept of 'Dharma', loosely translated as duty of an individual, and described and studied the ritualistic practices as mentioned in the Vedas.

'Vedanta', which translates to the 'end of the Vedas', summarizes the knowledge of the Vedas as expressed in various Upanishads which are philosophical discussions on the nature of reality. Badrayana wrote the Brahma Sutras or the Vedanta Sutras which is a terse set of aphorisms that deal with the existence and nature of reality, concept of soul or atman, relation with Brahman, the purpose of life and the theories of cause and effect.

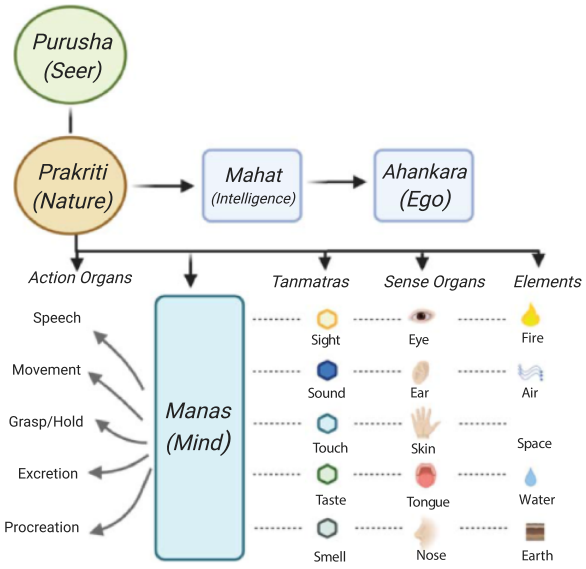
Box 2: Sankhya philosophy

Sankhya is an enumerationist philosophy aimed at characterization and specification of parts of existence and reality. Sankhya is a dualistic approach to reality where consciousness or 'Purusha' along with 'Prakriti' exists. The 'Prakriti' is manifested as various 'tattvas' or part of reality. First being the 'Mahat tattva' or

Box 1 Figure 1: The six systems of orthodox Indian Philosophies.



Box 2 Figure 1: The twenty-four tattvas of Sankhya including Purusha.



intelligence of the nature which abstracts as 'Buddhi' or intellect in individual organisms. 'Ahankara' separates the reality in the five 'bhootas' or elements: air, water, earth, fire and space. And the other aspect of this division is the 'Manas'/mind which also incorporates memory. This mind develops further into the organs of action, senses and tanmatras. There are five of each. The five tanmatras of taste, touch, smell, sound and sight are associated with the corresponding sense organs tongue, skin, nose, ears and eyes which in turn are associated with the five elements of water, space, earth, air and fire. Three 'gunas' or quality rule in the nature: 'Sattva' which brings harmony, lightness and balance; 'Rajas guna' which is responsible for the activity, change, energy and transformation; and 'Tamas guna' which represents dullness and inertia. The five elements are associated, with the 'prakriti' being affected by the 'tamas guna', and 'rajas guna' brings about a transformation in these elements and makes them a part of the mind, sense and action organs which are due to the action of 'sattva guna'. The 'gunas' or quality are associated with different states of the mind and body. These are classified into three: 'sattva' causing lightness and balance, 'rajas' leading to restlessness, activity, aggression and 'tamas' causing dullness, lethargy and inertia.

The goal of the human birth, 'Sankhya' postulates, is the end of suffering or 'dukha' through breaking the bondage of the 'ahamkara' and realizing the true nature of 'Purusha' or the seer/soul/atman and not of the 'Prakriti' or nature.

Box 3: Yoga sutras

The 'Sutra' or aphorism system of exposition as practised in ancient India was used to summarize the conceptual understanding to as little syllables as possible without being repetitive and being as terse and condensed. The systems allowed easy transmission of knowledge but being terse were prone to incorrect interpretations. The 'Sankhya' philosophy is summarized in 72 'sutras' (Virupakshananda 1995) whereas the Brahma 'sutras' are expounded in 555 'sutras' (Vireswarananda 1936). Yoga is the practice-focused philosophy aimed at the reduction of misery, increase of joy and eventual enlightenment through realization and being firmly established in the nature of the seer. Misery is attributed to seeds of ignorance ('Avidya') or impressions that the subject is different from the world. There are 196 'sutras' divided into four chapters. The first chapter describes the different modulations of mind, internal states, types of 'samadhi', and coming to the state of yoga through practice and dispassion. It also lists out some techniques to help a quivering mind settle down when faced by various obstacles. The second chapter talks about the practice in more detail, what to practice and how to practice; it describes the eight limbs of yoga—'Yama', 'Niyama', 'Asana', 'Pranayama', 'Pratyahara', 'Dharana', 'Dhyana' and 'Samadhi'. The state of 'samadhi' has many finer nuances explained in the main text. 'Samadhi' allows to burn the seeds of ignorance and get established more and more in the true nature of the seer which is bliss, joy and peace.

Chapter three relates to the abilities gained through the practice of 'Dharana', 'Dhyana' and 'Samadhi', and the final chapter talks about the method and the process towards 'kaivalya' or enlightenment when the fetters of ignorance or ego have left the mind and it can totally become one with the seer.

Organization of consciousness

According to 'Sankhya' philosophy (Virupakshananda 1995), the world is composed of consciousness (Seer/'Purusha') and creation ('Prakriti') which itself is the total of twenty-four 'tattvas' including the sense organs, 'tanmatras', action organs, elements, mind, intellect and ego along with memory. In our YTC, we extend this philosophy into a model as illustrated in Fig. 1 which represent the various faculties of each individual. The sense organs bring in data and knowledge about the world, filtered through the 'Tanmatras' or sensitivity/sensory specificity of each sense organ (not shown separately but built into the abstraction of the sense organs). The way we have thought of is that sense organs are not just the physical organs of sense but also includes the regions in the brain which are specific to the processing of each sense. For example, the eyes, retinal ganglion cells, lateral geniculate nucleus and then onto the early and late visual cortex are all abstracted as the visual sense organ. The mind composes and interacts with these senses and make decisions based on the intellect subsystem along with

memory and ego subsystems and then sends the output signal to the motor organs which form an abstraction including the motor cortex, parts of the cerebellum (for simplicity not included in the figure) and the peripheral nervous system.

As compared to the 'Sankhya' model described in Box 2 which refers to the twenty-four 'tattvas' related to external sense perceptions in humans, we have also included the internal sense organs in the YTC model. And our abstraction can be generalized over different species of animals and not just humans. Although we have not shown subcortical regions in the representations on Fig. 1, they are assumed to be a part of the sense organs. We look closely at each individual system in the sections below.

Sense organs

We perceive the external world through the five senses of touch, taste, sight, smell and sound and the internal world through nociception, proprioception, balance and interoception. The sense organs as abstracted in the YTC model are not just the sensory receptors but composed of the whole hierarchical processing involved, including the receptors, ganglion cells and peripheral nervous system, to the thalamus and the brain. For the visual sense, higher areas like the V4/V8, medial temporal (MT) and intraparietal sulcus are also included. Similarly, for the auditory sense, ears, cochlea and thalamus up to the auditory cortex are all abstracted in the model.

Tanmatras

The concept of 'Tanmatras' is unique to 'Sankhya' and represents the subtle dimension of the senses. The idea of 'tanmatras' has been unexplored in consciousness sciences and in our model, we consider 'tanmatras' as composed of two aspects: specificity and sensitivity of a sense organ. Sensitivity refers to the range of sensory data to which the sense organ can respond, e.g. humans have a hearing frequency of 20 Hz to 20 kHz and dogs have a sensitive olfactory sense with up to 40 times more receptors than humans (Porter *et al.* 2007; Craven *et al.* 2010). Specificity determines the amount of sense data required to trigger a conscious perception of that sense. The sensitivity and specificity which determine the corresponding 'tanmatras' can change across species and even within individuals of the same species. Specificity of sense organs would depend on modulations (explained in the following section) including attention, inference, mind wandering and sleep. Attention has been shown to modulate perception (Carrasco *et al.* 2004; Ling and Carrasco 2006) via amplification of signals specific to a sensory type, time and location.

Action organs

The organs of action include the limbs, speech, organs of excretion and procreation and also all the muscular movements that can be done consciously. From the motor cortex to the peripheral nervous system, the regions responsible for motion or movement are a part of the organs of action. Although we have not shown the cerebellum in Fig. 1, it is an important part of the process of action even though the absence of it (Yu *et al.* 2015) has not shown much difference in cognitive abilities but only slightly impaired motor functions.

Internal faculties

Mind

The mind is a subsystem of the internal faculties. Along with intellect, ego and memory system, it works in close conjunction to create a continuity of perception and aids in planning, cognition, sensory integration and intention to move. Mind is the higher-order region that can deploy attention through the dorsal attention network (DAN) to amplify signals from the sensory systems to gain more knowledge of the world or it can go into mind wandering, imagination and thinking about the past and the future. Mind is the central system when we expect someone to be conscious. A lot of published studies interpret consciousness as the mind but yogic texts separate the mind from the other faculties. The mind assumes the form of its contents and when engaged with the outside world (scenery), it forgets the awareness of the seer. Desires arise in the mind along with the myriad of thoughts, intuition and creativity. It is affected by the modulations and loses track of the seer in the process. Yoga sutras point out that the time spent in modulations by the mind prevents it from completely experiencing the reality in the present moment now. All the practices and teachings of the yoga philosophy are aimed at reducing these modulations of the mind and removing the seeds or impressions in the memory which cause the mind to go into these modulations again and again. Through consistent practice of the eight limbs of yoga, the modulations of the mind get more and more restrained, which result in better concentration, an increase in joy and the feeling of oneness with the world.

The mind is best represented as composed of the default network [posterior cingulate cortex, temporoparietal junction (TPJ) and temporopolar cortex] and the attention network (parietal cortex and frontal eye fields). A lot of studies assign the seat of consciousness as the posterior parietal cortex (Koch *et al.* 2016) but we argue that instead it is the seat of the mind. The research paradigm that is targeted to the study of the seer actually studies the mind.

According to YTC, the development of mind is closely linked to the number and type of sense organs, their associated 'tanmatras', and the number and type of action organs. Organisms with different sense organs, action organs and 'tanmatras' will have a 'different' or 'unique' internal faculties. The mind of a dog that has a different 'tanmatra' for olfactory sensations would have different mental processes than humans or even dolphins which could sense bands of electromagnetic waves that we cannot. The mind is unique to every organism and we should not expect direct correlations in the neural processing and signatures across species until we fix the three—sense organs, action organs and 'tanmatras'. We should expect to see conserved principles across species but any cross-species analysis should not be wildly extrapolated. The development of the mind across species can be an important step in understanding the limits of conscious processing.

Intellect

The intellect subsystem is a part of the internal faculties and is related to decision-making, filtering thoughts that come up in the mind and are represented by the Cognitive Control Network.

Memory

Memory subsystem centred in the hippocampus and amygdala is associated with memory formation but there are evidence of the wide-scale cortical involvement in long-term memories. A ton of work have been done in this field with regard to the actual dynamics of memory formation, extinction, affect-based memories, spatial memories, etc. (Gabrieli 1998). In our model, memory holds the information for any event. It is also

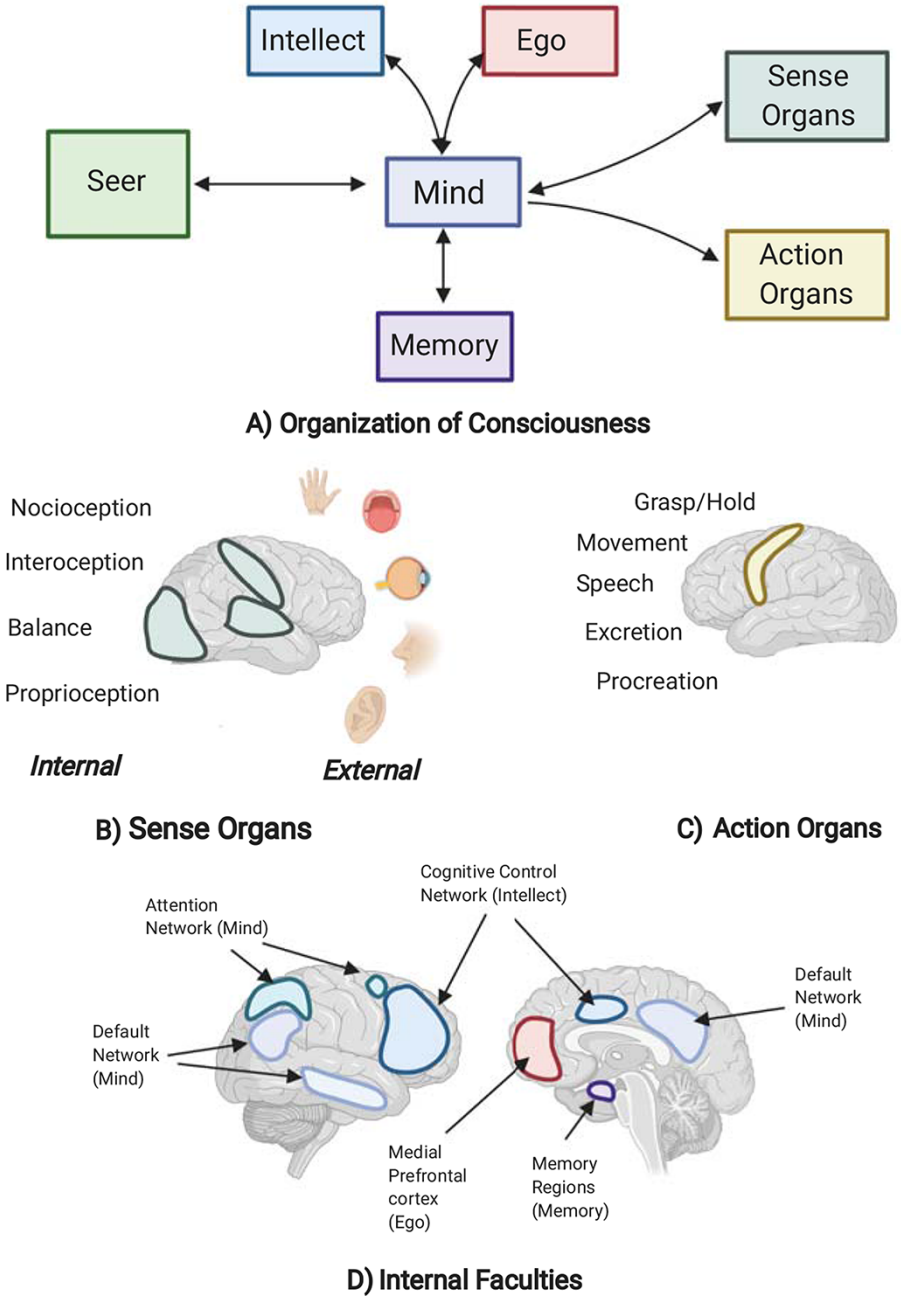


Figure 1. Yogic theory of mind and consciousness: A) The organization of consciousness according to YTC. Sense and action organs represent external faculties that enable interaction with the world. In this and subsequent figures, the direction of the arrows represents the flow of information or cause–effect relationship, the width of the connecting arrow depicts the strength of the connection, faded region and arrows represent a temporary reduction in activity and connection, respectively, and a broken arrow represents disconnection whereas red cross represents damaged physical connection. B) Sense organs comprise external senses like taste, touch, smell, sight and hearing, and internal senses like nociception (pain), proprioception, interoception and balance. Tanmatras or sensitivity and specificity of each sense organ is an internal property and not described in the figure here. Brain regions like occipital cortex are considered a part of the sense organ in the YTC, similarly for the somatosensory cortex, auditory cortex and olfactory region. C) Action organs of movement, hold/grasp/push, speech, excretion and procreation are represented in the motor cortex which is considered part of the action organs in YTC. D) Internal faculties of the intellect, ego and memory interact through the mind. The mind constitutes the default network and the attention network (not all regions of the networks are represented in the figure). The intellect is represented in the prefrontal cortex also called cognitive control network (which includes frontoparietal control network; not all regions are represented in the figure) and the ego (self-referencing) in the medial prefrontal cortex (mPFC). The hippocampus and amygdala are the regions associated with memory. All these faculties working in conjunction perceive, cognize, think, remember and act. Seer, separate from the others, is the centre for awareness.

related to one of the modulations of the mind; when the connectivity between the mind (default network) and the memory region is high, the mind spends a lot of time thinking about the past.

Ego

Ego subsystem is associated with self-referential processing, risk-taking and centred around the mPFC. Many studies put it as a part of the default network (Christoff *et al.* 2016) but it is closely

linked with the mind, intellect and memory. Damages to this region have shown reduced risk aversion (Spaniol *et al.* 2019). We further hypothesize that increased connectivity between the ego and default subsystems could be linked to narcissistic personality traits.

Seer

Seer is the finest aspect of consciousness and represents the seat of awareness. It perceives the world through the mind which is affected by modulations. Yogic texts relate to it as the source of conscious awareness, joy and happiness. Self-realization or 'kaivalya' is found when the practitioner becomes totally aware of the seer through the reduction of memories and modulations. Indian philosophers consider the realization of the seer as one of the most important goals of life (Shankar and Ravi 2010; Vivekananda 2018). We are of the thought that current neuroscientific research has looked into the aspects of the mind and the modulations of the mind but has not investigated the neural correlates of the seer. Research into the meditation techniques especially where the modulations do not exist in the mind ('Nirvichara/Nirvikalpa Samadhi') can show a better understanding of the seer.

Modulations of mind

The purpose of yoga as a practice is to silence the modulations ('vrittis') of the mind so that the mind can be established in the seer. These modulations can be either painful or not. When the modulations are active, the mind is engaged with the scenery (sense organs or knowledge related to sense organs). Yoga sutras (Hartranft 2003; Shankar and Ravi 2010; Vivekananda 2018) propose the presence of five modulations: proof or means of knowledge ('Pramaana'), wrong understanding of knowledge ('Viparyaya'), imagination ('Vikalpa'), sleep ('Nidra') and memory ('Smriti'). 'Pramaana' or means of knowledge can be of three types as accepted in the sankhya and yoga philosophical schools: perception/'Pratayksha', inference/'Anumaana' and documented evidence/'Agama/Shabd'. 'Pratyaksha' means gaining knowledge through the sense organs directly, 'anumaana' means making an inference on the information captured through the sense organs and 'shabd' means utilizing the evidence documented by an authentic source. An example is cited in many Indian philosophical texts to describe the three: consider being in a forest, and you see smoke—you infer that there should be a fire nearby ('Anumaana'/Inference). As you go nearer, you visually confirm the presence of fire ('Pratayksha'/Perception). You know from knowledge gained from experience or documented evidence ('Shabd') that covering the fire up can extinguish it by cutting the oxygen source. The means of knowledge takes the mind away from the seer and thus engaged in the scenery. The other modulations 'Viparaya' is wrong knowledge not based on the true form of an object. Example: You cross the street and a few people start laughing and you think to yourself if they were laughing at you? 'Vikalpa' or imagination follows from word and knowledge of the word but devoid of any object. Memory ('smriti') or remembering the past, reliving the experiences from the past, or thinking about events from the past which do not exist now is also considered a modulation of the mind along with sleep/'nidra' where the mind has no content (Hartranft 2003; Shankar and Ravi 2010; Vivekananda 2018).

Sleep as a modulation

Sleep has been understood to be a state of consciousness where there are no contents of the mind yet sleep research have depicted that it is a very active process, from waste clearance by the flow of cerebrospinal fluid (CSF) (Xie *et al.* 2013) and sleep spindles (Ujma *et al.* 2020) to memory consolidation via neural slow waves. Both the processes were found to be related (Fultz *et al.* 2019) recently. Papers have proposed that local sleep can occur during wakefulness and may be responsible for attentional lapses (Andrillon *et al.* 2019). The yoga sutras classify sleep as a modulation of the mind which not only occurs once or twice during the day/night for an extended period but also small short bursts or local periods of sleep. We argue that sleep is not a different state of consciousness but a modulation of the mind. It is a physical process required by the body to carry out maintenance activities but expert meditators and yogis have been suggested to reduce the need for sleep through years of practice (Kaul *et al.* 2010). The research is lacking in this domain as only recently scientists have started to piece together the importance of sleep in our lives (Xie *et al.* 2013; Fultz *et al.* 2019) but how yogic practice can reduce the need for sleep needs to be studied carefully. We also propose that local sleep and extended sleep during the night time would have similar characteristics in terms of neural patterns especially in the mind subsystem [default network (DN) and DAN regions]. We describe the rapid eye movement (REM) and deep dreamless non-REM states using YTC in Fig. 2.

Attention as a modulation

Attention has been researched extensively over the last few decades. Attention has been shown to alter perception (Carrasco *et al.* 2004; Ling and Carrasco 2006) by amplifying the signals at the focus of attention and attenuating other signals. Yoga sutras consider attention as a means of gaining information and knowledge about the world which in turn alters our perception of the world (Carrasco *et al.* 2004). Attention is thought of as a modulation of the mind as it takes the mind away from the seer which is the source of awareness to the scenery. Attention modulates the content of the mind. Yoga texts have described the role of attention in practices like 'dharana' and 'dhyana' and suggest that intense attention to any one of the sensory streams reduces all other modulations of the mind and the mind becomes alert and focused. Awareness and attention are often confused. We believe that attention is a process of the mind regulated with the DAN and required dedicated resources from the brain, and engages effort so much so that people prefer pain over attending for long durations or harder tasks (Vogel *et al.* 2020). However, awareness is the property of the consciousness in general and seer in particular. We are always aware and only during the times of modulations our awareness reduces. Awareness can also be thought of as salience and may have possible correlates in the ventral attention or salience network.

Mind wandering as a modulation

We set our mind to a task at hand, maybe reading this paper or doing some analysis and the mind starts to drift and some thoughts come up of the past and some imaginations about the future, we may think about what someone said or imagine what would one do in a situation if it shows up. We all have observed the mind wandering but the awareness of the wandering mind

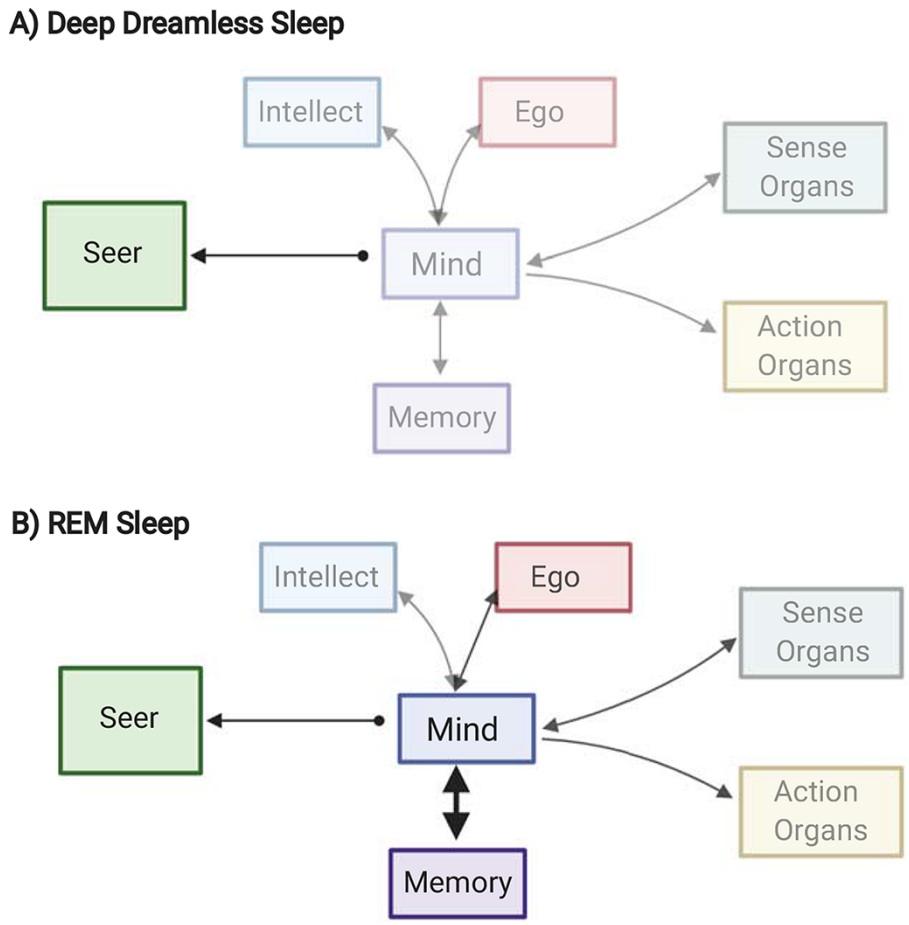


Figure 2. Sleep as a modulation of mind: our model argues that instead of understanding sleep as an altered or different state of consciousness, it should be thought of as a modulation of the mind where A) the mind either has no content (deep dreamless sleep), the connections with the sense and action organs are reduced and the internal faculties have decreased communication with each other and also have reduced activity. B) REM phase of sleep involves vivid dreams and occurs every 90–120 minutes where memory consolidation happens along with CSF recycling (Fultz et al. 2019). In our model, the mind and the memory subsystems are strongly connected during the REM phase with some activity in motor organs and possibly some in the visual regions.

comes after the mind has gone off for some time. We suddenly realize that we have not done anything or probably missed out on some parts of the conversations with someone. YTC considers mind wandering as a modulation composed of 'Vikalpa' or imagination which could be constrained or spontaneous. It is separate from 'Smriti', which is a remembrance of events, and from 'Viparyaya' where the mind perceives and infers incorrectly. There have been recent attempts to study mind wandering (Smith *et al.* 2001; O'Callaghan *et al.* 2015; Christoff *et al.* 2016; Schacter *et al.* 2017; Scheibner *et al.* 2017) but still, it is in its nascent stage. Current neuroscientific research on the mind wandering contextualize thoughts either generated spontaneously or deliberately and with constrained focused towards a task at hand (Christoff *et al.* 2016). Frontoparietal control network can exert deliberate control over the thoughts but spontaneous thoughts are generated in the middle temporal lobe (MTL) subsystem of the DN. The core network of the DN comprising posterior cingulate cortex and posterior inferior parietal lobule automatically constraints the thoughts related to the individual. The activity of the brain during wakeful rest is found to be in two prominent states (Karapanagiotidis *et al.* 2020), which correspond to the modulations of memory ('smriti') and imagination ('vikalpa').

Mind wandering is usually thought of as noise in the mind and behaviourally estimated out using reaction times and accuracy on task. But such experiments and studies ignore the state of mind wandering, an important aspect of the mind. When we understand that mind wandering and attention are modulations of the mind (as illustrated in Fig. 3), it can help us design better behavioural experiments. Although the study of mind wandering is dispersed and there are no cohesive methods to detect when the mind wandered without probing (Weinstein 2018), we believe that full neural correlates of consciousness would include both the neural correlates of attention and mind wandering.

Internal states of yoga

The different states of mind and consciousness according to YTC are listed in Table 1. When the mind is not in the five modulations, it is not seeking knowledge about the world and is not engaged in self-referential processing, imagination, incorrect knowledge, sleep or memory, it is said to be in the state of yoga. There are further states of 'dharana', 'dhyana', 'samadhi' and 'samapatti'. The state of 'samadhi' is further divided into 'sabeeja samadhi' and 'nirbeeja samadhi'. The latter is experienced after years of practice and is considered a goal for yogis and practitioners but the former has nuances and subtle states within it. We would look closely at each of these states and how YTC can model and experimentally investigate them. Buddhist literature also mentions the

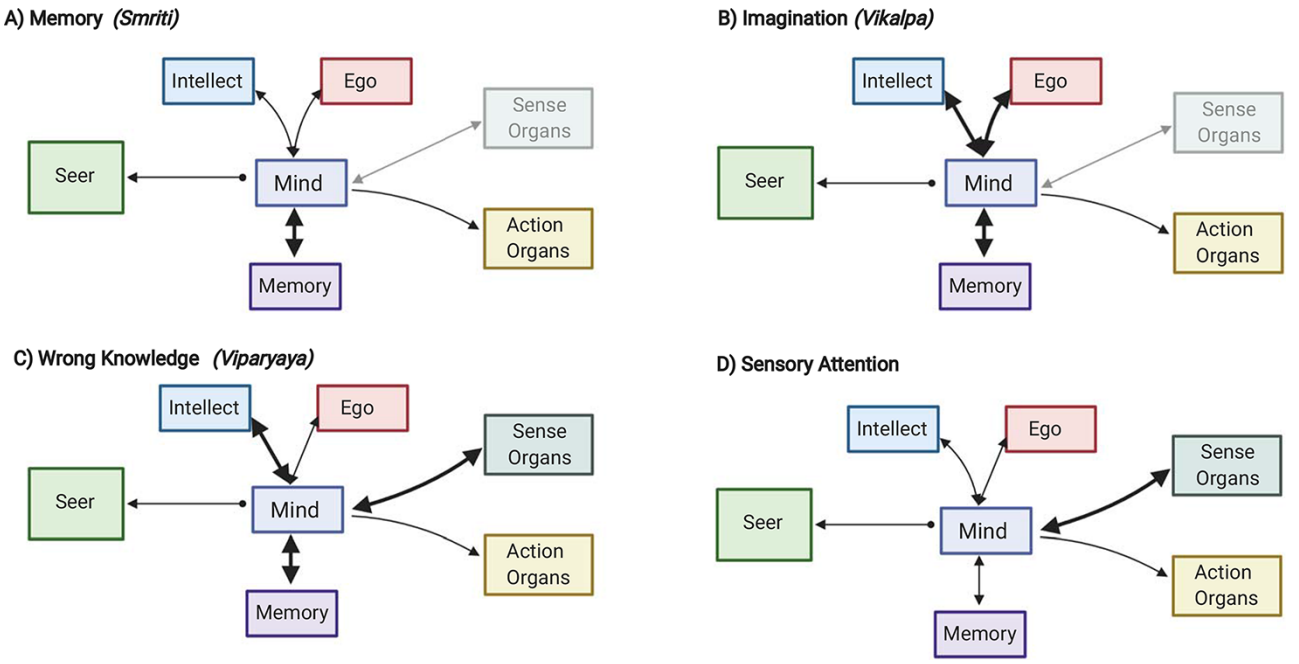


Figure 3. Mind wandering and attention as modulations of the mind: A) When the mind is engaged in the memory or the remembrance of the past events, the sensory data are unattended to and the mind engages strongly with the memory system, and the connectivity with the seer is reduced. B) During imagination or vikalpa, a word or a thought in the mind starts a stream of self-referential processing involving the ego and the intellect subsystems with sensory data unattended and awareness from the seer reduced. C) During wrong knowledge of a percept, the connectivity with the intellect, memory systems and sense organs is increased whereas it decreases with the seer subsystem. D) Sensory attention or perceptual proof (Pratayksha Pramaana) where the connectivity between the mind and the seer decreases, and the mind engages with the outside world through the sense organs, increasing the sensitivity and specificity of the incoming sensory signals, and the signals from the memory regions are also reduced.

state of 'Jhanas' (Hagerty *et al.* 2013) or 'dhyana' in Sanskrit which are probably close or similar to the states described here as mentioned in the yoga sutras (Flood 2013; Rose 2016). A meta-analysis found some differences (Tomasino *et al.* 2014) between the states but additional neuroscientific evidence is warranted to compare the different traditions objectively.

Internal states

'Pratyahara' is the process of taking the attention and the mind from the external sense objects to internal senses like proprioception and interoception which allows the reduction of modulations and serves as a process to go into the finer and less perturbed states of 'dhyana' and 'samadhi'.

'Dharana' (concentration) is another internal state where through taking attention to a fixed location the modulations of the mind are reined in. Different yoga and meditation practices have used various methods for 'dharana' including attention to parts of the body, specific locations such as 'chakras' or ganglions, sensations of the body, attention to breathing, unbroken attention to a point ('trataka'), repeated chanting/'japa', etc. (Deepeshwar *et al.* 2019). All the subsystems of the mind and consciousness are active with attention to internal or external sense organs and the modulations begin to reduce. Attention regions are active along with amplification signals to one of the senses. Default mode activity has reduced and disconnects with the attention network.

'Dhyana' or meditation is the state achieved when the modulations have reduced, with only one content of mind which is continuous and not changing. There is no impulse to act, the connection with the action organs is reduced and other systems are active but the mind is coming back to a singular content. We can think of it as an attractor state of a dynamical system (Bærentsen 2015). The attention network is still active but the amplification of the sensory signals have decreased. The default mode system

Table 1. The different states of mind and consciousness.

S. No	State	Type
1	Nidra (sleep)	Modulation
2	Smriti (memory)	Modulation
3	Pramaana (proof)	Modulation
3.1	Pratayksha (perception)	Modulation
3.2	Anumaana (inference)	Modulation
3.3	Shabd (documented evidence)	Modulation
4	Viparyaya (wrong knowledge)	Modulation
5	Vikalpa (imagination)	Modulation
6	Pratyahara	Yoga
7	Dharana	Yoga
8	Dhyana	Yoga
9	Samapatti	Yoga
10	Samadhi Sabeeja (with seeds)	Samadhi
10.1	Sampragyat (with awareness)	Samadhi
10.1.1	Savichara (with thoughts)	Samadhi
10.1.2	Nirvichara (without thoughts)	Samadhi
10.1.3	Savitarka (with logic)	Samadhi
10.1.4	Nirvitarka (without logic)	Samadhi
10.1.5	Anand (with bliss)	Samadhi
10.1.6	Asmita Arupa (with I-ness)	Samadhi
10.2	Pragyapoorvak (arising out of awareness)	Samadhi
10.2.1	Shraddha (faith)	Samadhi
10.2.2	Veerya (valour)	Samadhi
10.2.3	Smriti (remembrance)	Samadhi
10.2.4	Prakriti Laya (synced with nature)	Samadhi
11	Samadhi Nirbeeja (without seeds)	Kaivalya

has reduced activity and decreased connectivity within the network and with attention network (Nash *et al.* 2013; Raffone *et al.* 2019). Thalamocortical signals from the multiple demand regions of the thalamus have reduced the firing rate in the cortex (Aru *et al.* 2020; Bachmann *et al.* 2020). Alpha and Theta power increase in deep states of meditation (Travis and Keith Wallace 1999; Baijal and Srinivasan 2010) and hemispheric band power synchronizes (Bhaskar *et al.* 2020).

'Samadhi' is staying in the state of 'dhyana' long enough that the content of the mind disappears; there can be thoughts, some logic, feelings of bliss and joy, and sense of I-ness but the mind has no continuous content. It is an equanimous state where there are no modulations: mind wandering, memory or sleep. Default mode activity is low and disconnected, the attention network activity has also reduced and the sensory signals are attenuated.

'Samapatti' is a trait feature that is achieved after practice for many years: perception of the world is clear and the mind does not wander, there is no local sleep and affective stimuli do not create strong memories (PYS 1.41). Experienced meditators and yogis stay in the state of samapatti where the default mode activity and connectivity with valence regions and memory regions are reduced. 'Asana' or posture practice can also bring in a temporary state of 'samapatti' (PYS 2.47) wherein putting effort and letting go takes the mind temporarily to the state of 'samapatti'. We have demonstrated in Fig. 4 how these internal states would be modelled by YTC.

States of samadhi

'Samadhi' has multiple nuanced states as mentioned in Table 1 and illustrated using YTC in Fig. 5. We can first describe two types of 'samadhi'

(i) 'Sabeeja Samadhi': The states of 'samadhi' with the seeds of ignorance; they are further divided into
  (a) 'Sampragyat Samadhi': State with awareness where one can observe spontaneous thoughts, special logic about oneself, feeling of bliss and joy and the mind is established with the seer, it is further divided into:
    (1) 'Savichara': with spontaneous thoughts, we propose that in such a state, the MTL subsystem of DN would be active.
    (2) 'Nirvichara': without spontaneous thoughts and no firing of the DN–MTL subsystem.
    (3) 'Savitarka': with special logic, frontoparietal network and cognitive network would be active and connected with default network.
    (4) 'Nirvitarka': without special logic, frontoparietal network would be inactive and disconnected.
    (5) 'Asmita Arupa': with a feeling of I-ness, the mPFC would be active with connectivity with default and attention regions.
    (6) 'Anand': with feelings of bliss and joy.
  (b) 'Pragyapoorvak Samadhi': The states of 'samadhi' which are reached by being aware and in the state of action where the mind spontaneously drops off the modulations and becomes one with the seer.
    (1) 'Shraddha': a spontaneous state of 'samadhi' reached during intense periods of religious or spiritual activity.
    (2) 'Veerya': When valour is invoked, it brings in about a spontaneous state of being aware of the self and the seer.
    (3) 'Smriti': Memory of a deep experience of 'samadhi' can itself take one into samadhi.
    (4) 'Prakriti Laya': When we see a beautiful sunset across the ocean and the mind totally settles in, for brief moments 'prakriti laya samadhi' occurs, which translates to being in unison with nature.
(ii) 'Nirbeeja Samadhi': The state of samadhi where there are no seeds of ignorance left and the modulations of mind have ended; the individual is totally one with the creation 'kaivalya' or enlightenment is experienced.

Neural correlates of consciousness

How and why we have any experience is expressed as the hard problem of consciousness (Chalmers 1995). How could matter come together and form experiences is still unclear. The materialist perspective postulates that consciousness should be an emergent property which develops out of the complex computations in the billions of neurons that the human brain possesses. But, the recent studies on corvids (Nieder *et al.* 2020) and other animals (Birch *et al.* 2020) suggest that animals with an entirely different and much smaller brain structure can still possess consciousness. Either different number and configurations of neurons can bring together a similar emergent property or the circuitry required to bring emergence is not as complicated.

YTC considers consciousness to be a fundamental property of life but the mind to be an emergent process out of configuration of the sense and action organs. Higher-order processes involve the intellect, ego and memory subsystems (represented in the cognitive control system, mPFC and hippocampus) along with the mind. As different species possess different attributes of intelligence, sense and action organs, we can expect their internal faculties to have different properties as compared to humans like corvids engage nidopallium caudolaterale in higher cognition (Nieder *et al.* 2020) whereas mammals utilize PFC for intelligent behaviours. The separation between the neural correlates of consciousness and neural correlates of mind and other internal faculties can help us understand the specific role of these faculties to create a cohesive cognitive unit.

Then, what are the neural correlates of consciousness? According to our model, the seer is deeply integrated with the mind. Any study that can help us understand the seer or the seat of consciousness (according to the yogic model) and determine its physical correlates will be limited by the state of the mind. If we have the neuroscientific correlates of all the states of the mind, then when the mind is switched off, it can help us detect the physical correlates of the mind without the confounds of the mind. Two processes of Nirbeeja Samadhi and general anaesthesia switch off the mind, and neuroscientific and biological signatures of these states can help determine the physical correlate of the seer. General anaesthesia although easy to administer causes chemical-based increase or decrease in Gamma-Aminobutyric Acid (GABA) or N-methyl-D-aspartate (NMDA) receptors, whereas 'Nirbeeja Samadhi' comes through years of training and thus is more natural and would involve long-term changes in the brain that can sustain the state closest to pure awareness and not affected by the modulations and activity of the mind.

Disorders and altered states of consciousness and YTC

Accidents, injuries or disorders can cause altered states of consciousness. Traumatic brain injury, coma and locked-in syndrome are some of the conditions that can cause a different than normal

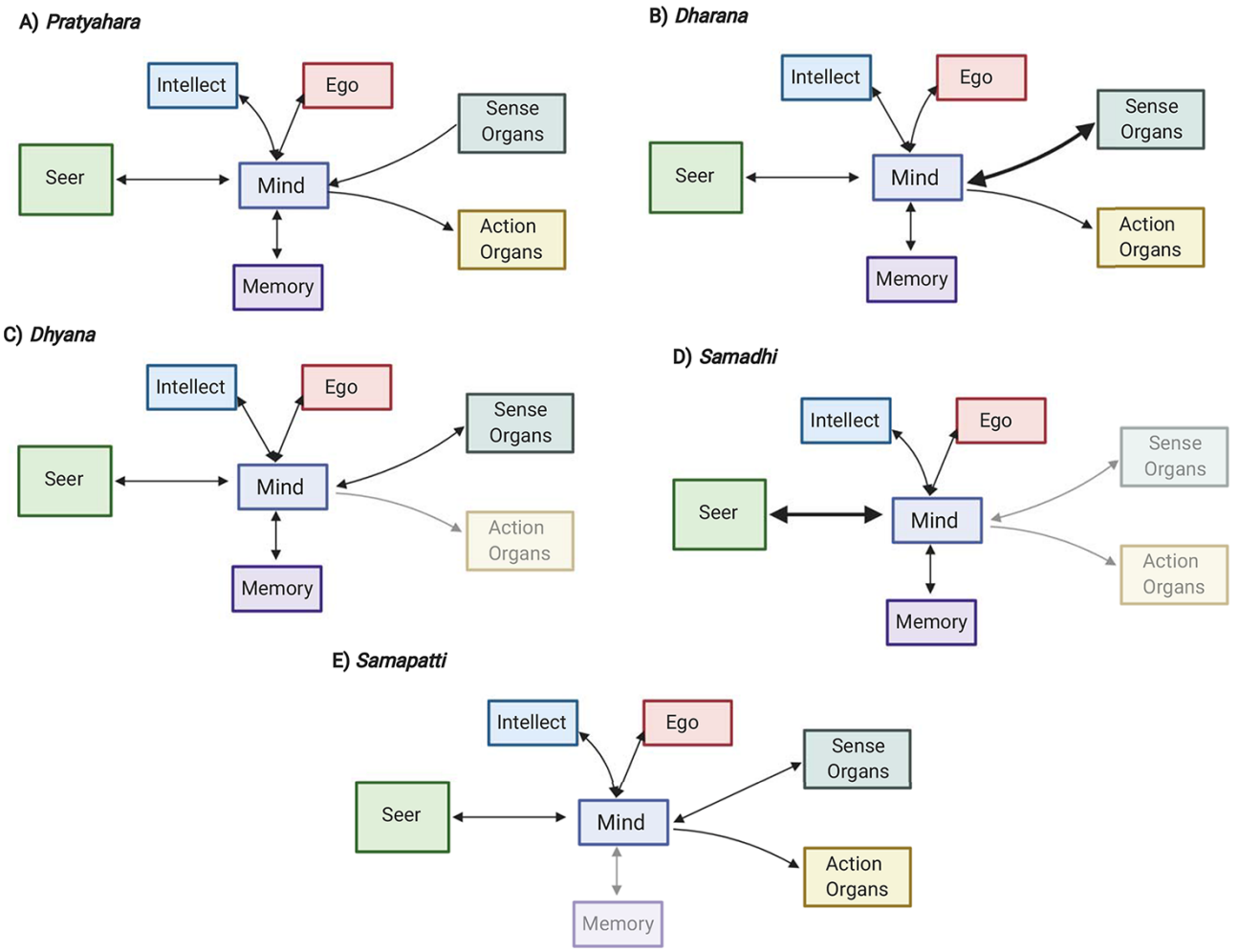


Figure 4. Description of the internal states according to the YTC: A) Pratyahara translates to giving alternate food to senses; the attention is drawn from all the external senses to internal sense perceptions. B) Dharana or concentration is a practice to take attention to an object, a sensation in the body, a repeated word or mantra, but with a singular focus on one object or location, the signals to which the mind then amplifies. C) Dhyana or meditation happens when the modulations start subsiding and the intellect and memory become less connected to the mind. The content of the mind is singular and continuous. D) Samadhi or transcendence is an equanimous state where the mind drops the content it is holding onto during dhyana, modulations have subsided and focused onto the seer (aware of simply being), and the inputs from sense organs are still coming but not changing the content of the mind. E) Samapatti is a state of being aware of both the seer and the scenery; modulations are subsided and impressions or memory not active as not many associative memories are formed.

consciousness (Bayne *et al.* 2020). Local anaesthesia can totally remove the pain (Purdon *et al.* 2015). General anaesthesia can cause total blankness and the subjects do not even recall how much time has passed in such a state (Brown *et al.* 2018). There has been no concrete solution for this aspect from the theoretical standpoint. Here, we argue (as illustrated in Fig. 6) that under these two mechanisms of reduced integration between the systems, either the activity in a system is reduced or the systems are disconnected. Using perturbational complexity index (PCI; Casali *et al.* 2013), which uses TMS along with EEG, we can test the integration between the various subsystems of YTC model as stated in Fig. 1A. Locked-in syndrome causes the disconnect with the action organs and the patient is unable to move any part of the body other than the eyes. Coma results in the decrease in the amount of sensory information coming in to the patient but totally disconnected action organs. Local anaesthesia results in the disconnection of nociception in specific parts whereas general anaesthesia causes a reduction of integration across systems but with local neuronal activity within networks.

Loss of cerebellum

Cerebellum has always been thought to be related to motor processing but recent studies have started to find more involved role in cognition (Brissenden *et al.* 2016; Bostan and Strick 2018). Researchers have argued the specific contributions of the cerebellum to consciousness. A subject was found to be living healthily without a cerebellum with only minor motor problems (Yu *et al.* 2015). In our model, cerebellum is not included in the internal faculties and hence play no specific role in the mind, intellect, memory, ego or as the seer. We might need to include the cerebellum as the exact function of it becomes clear. It might be involved in the intellect network, the mind network or the ego network sep-

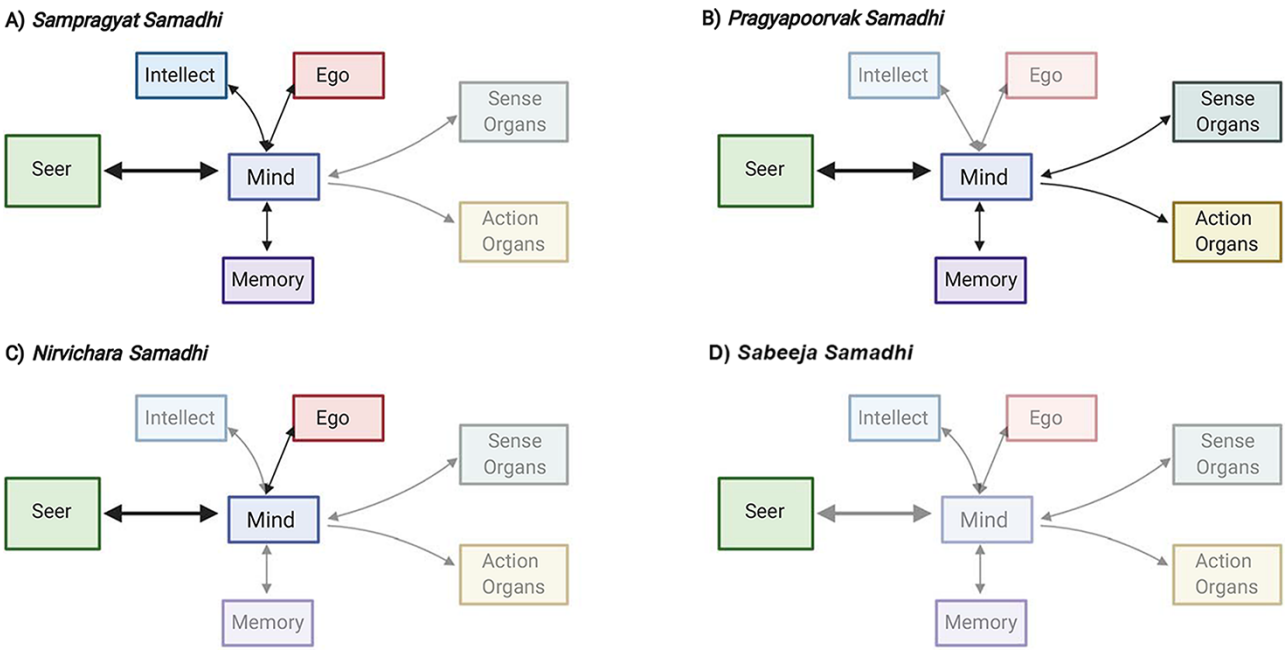


Figure 5. Description of the finer states of Samadhi: A) Sampragayat Samadhi: state of samadhi or equanimity with awareness wherein sensory activity decreases, spontaneous thoughts arise, some logic about the mind and body can form and be accompanied with the feeling of elation and joy with a sensation of 'I am experiencing' or 'I am being'. B) Pragyapoorvak Samadhi: a state that comes after awareness and can be invoked using memory of an event, valour or faith. Runner's high, deep religious and spiritual experiences come under this classification of Samadhi. C) Nirvichara Samadhi is a state similar to (A) but without spontaneous thoughts, and similarly a state is called Nirvitarka Samadhi which does not involve any logic in the mind. D) All these states of samadhi come under Sabeeja Samadhi which means a state of equanimity where the memory, impressions and seeds are still active whereas Nirbeeja Samadhi is a state that one goes beyond the limits of the mind and memory and is free from any impressions or seeds, also called as state of enlightenment of Kaivalya where only the seer remains and the feeling of oneness with the whole creation is observed.

arately as some functional connectivity studies have suggested (Buckner *et al.* 2011). More work is required to establish the exact role of the cerebellum in motor, cognition and consciousness.

Damage to prefrontal cortex

The case of Phineas Gage has depicted the role of PFCs in behaviour and self-control. As the intellect and ego network are found in the frontal regions, according to YTC, we posit that the mind of such a person would be intact but the intellect and ego faculty would be damaged and can cause changes in personality and make the patient unable to do various cognitive tasks.

Split brain patients

Corpus callosotomy, or separation of the two hemispheres of the brain, has been used as a treatment for severe cases of epilepsy. It results in very peculiar observations like when an object is placed on the left visual field of a patient, it can detect the object and even draw the object using the left hand but cannot say it out loud as the left visual field is represented on the right hemisphere of the brain which in turn does not communicate with the left hemisphere which is related to speech and vocalization. For such cases, using the YTC model, we suggest that the mind subsystem would be its.

Predictions

YTC provides us a tiered model of understanding the external world, internal faculties which perceive and act upon the world, and the innermost faculty or the seer which is aware of the world. The concept of bringing together the modulations of the mind along with inner states of meditation and yoga can provide a better interpretation of various phenomena.

Can machines be conscious?

According to 'Sankhya' philosophy the world including the action organs, sense organs and the internal faculties are emergent properties of the nature. As our devices become more and more complex with increasing levels of abstraction, it would be possible to create machine analogues of sense organs and motor organs. Recent advances in deep learning (DL) has allowed high-performing visual systems which can be extended to other sensory systems as well. The progress in robotics, bio-inspired prosthetic and brain–computer interfaces can allow us to replicate our motor functionalities better. DL has already conquered the field of computer games with systems like AlphaGo and AlphaStar (Silver *et al.* 2016; Vinyals *et al.* 2019), so it is quite possible that the intellect network could be created. Other aspects of 'Prakriti' like the mind, memory and ego technically could be machine replaceable given in the coming decades we understand the dynamics of these networks across species. As the seer is the fundamental aspect of reality, a machine analogue is not possible but hybrid systems can have the possibility of consciousness according to the Sankhya understanding.

Qualia through region stimulation

A persistent question that has been asked to the different theories of consciousness: 'Why are qualia invoked when specific brain regions are activated?' (Balduzzi and Tononi 2009) Stimulation through TMS or tDCS to frontal eye field region, MT, V4/V8 and other regions can invoke the qualia for faces, motion and

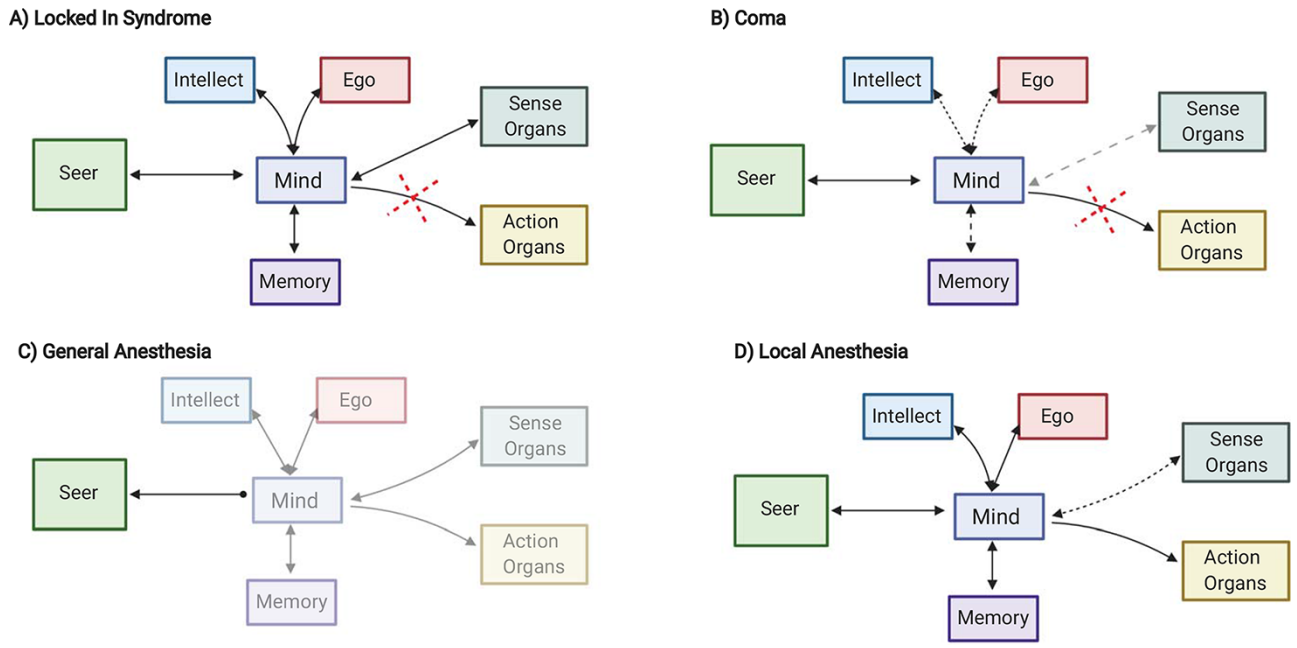


Figure 6. Explanation of disorders or altered states of consciousness using the YTC model. A) Locked-in syndrome is represented by the lack of motor movements but the subject is conscious; we propose that the connection with the motor organs is severed, resulting in a conscious and aware subject with no movement. B) Comatose patients have been shown to have a degree or level of consciousness of sensory percepts although they cannot move. In our model, we suggest that there is a disconnection with the action organs and reduced connections with the sense organs; some senses might be more damaged than others. Although there are different types of coma, we represent here a case where there is no damage to the internal faculties. Some other forms of coma, resulting from injury, built up of toxins and irregular functioning of the internal faculties of mind, intellect, ego and memory, may have a range of symptoms and corresponding relation to the level of consciousness. C) General anaesthesia using chemicals like ketamine and propofol has been researched extensively; we hypothesize that the sense, action organs and the internal faculties are all shut in the sense that there is no long-range communication across the subsystems and activity is reduced within the subsystem. D) Local anaesthesia results in the temporary disconnection with the specific sense organs including the sense of pain (nociception) which results in reduced signals from the sedated part of the body.

colour, respectively (Valero-Cabré *et al.* 2017). According to the YTC-based organization of consciousness, these regions are a part of the sense organs. Hierarchical processing enables regions to be receptive to certain features more than others. Activation through techniques like TMS or tDCS, perpetuate signals downstream which could otherwise come from the subsequent sense organ. We can further extend this to suggest that a similar kind of stimulation of processing regions in the auditory or somatosensory regions can invoke qualia of various features of sound.

True resting state

Serendipitous discovery of the default network activation in the brain during no task condition (Raichle *et al.* 2001; Gusnard and Raichle 2001; Buckner *et al.* 2008; Buckner and DiNicola 2019) created a whole field of neuroimaging known as resting-state functional connectivity (Fox *et al.* 2005). It led to the development of biomarkers for different conditions like Parkinson's and attention deficit hyperactivity disorder (Sørensen *et al.* 2016). Still, after 25 years of the discovery, the actual cause for the default network activity during resting state and its anticorrelations with the DAN (Fox *et al.* 2005) has not been found. Recent attempts discover the role of high-cofluctuation activity being responsible for the connectivity patterns during resting state (Esfahlani *et al.* 2019). Other approaches have signified the role of intrinsic processing and mind wandering for the activation of the default network (Christoff *et al.* 2016). But we truly do not know the reason behind the default activity of the brain.

Understanding the modulations of the mind as specified in the YTC can help us detect a true resting state which would be free of imagination, mind wandering and other modulations. We predict that in such a state the overall default mode network activity would be reduced as compared to 'normal' resting state and explicit intrinsic processing paradigms (Andrews-Hanna 2012).

'Viparyaya', 'Anumaana' and temporoparietal junction

The TPJ has been found to be involved in theory of mind (TOM) (Saxe and Kanwisher 2003) and has been termed as the ability to think what the other person is thinking. The modulation of Viparyaya or incorrect knowledge is closely associated with TOM. Engaging in the thought of what the others are thinking is inference. As recent studies have suggested the role of TPJ in prediction (Koster-Hale and Saxe 2013), we hypothesize that tasks that can invoke 'viparyaya'/wrong knowledge about an object or 'anumaana'/inference about some non-perceptual object should activate the TPJ.

Role of language in intrinsic processing

Yoga sutras specify the role of language, and the understanding of language as a precursor to imaginative thoughts, unconstrained thinking and mind wandering (PYS 1.9). We propose that tasks that invoke the language regions would have effects on the default network. The connectivity between the language and default network would be predictive of cognitive health; the higher the connectivity, the more the mind would be prone to mind wandering and vice versa. The connectivity differences between the language and default mode network can be found

in meditators as compared to non-meditating healthy controls. Bilingual and multilingual people might have differences in connectivity between these regions as compared to monolingual people.

Perturbational complexity index of various modulations and internal states

Casali *et al.* (2013) devised the PCI (Casali *et al.* 2013) which utilizes activation using TMS followed by detection of brain waves using EEG to find if perturbation of a brain system causes changes in the activity of the stimulated region. We propose that the different internal states of 'dhyana', 'dharana', 'samadhi' and different types of 'samadhi' as stated in Table 1 would have different PCI values and EEG-based brain states.

Relation to current theories of consciousness

YTC can work well in conjunction with the current theories of consciousness. The integrated information theory (IIT) (Oizumi *et al.* 2014; Tononi *et al.* 2016) lays down axiomatic rules of how information integrates and determines through complex computations the amount of consciousness in each system (Koch *et al.* 2016). The sense organs in YTC integrate sensory information across multiple modalities and hence, YTC can implement IIT. IIT is limited in its perspective as it does not take into consideration action organs. Evolutionarily, the purpose of consciousness should not be only the integration of information but also planning and movement. From the bottom up, it would be hard to prove or disprove IIT in its current shape but extended format coupled with YTC can give it a lot of power. YTC also incorporates the concepts of higher-order theories (Brown *et al.* 2019) and global workspace theory (Dehaene and Changeux 2011) in the sense that the internal faculties of intellect, memory and ego are higher-order regions which interact with the mind which integrates information from the senses and composes and relays movement onto the action organs. The thalamocortical theory or the dendritic integration theory (Aru *et al.* 2020; Bachmann *et al.* 2020) provides the framework of the integration between the sense organs through the thalamus and the mind network. Although some parts of the AST (Graziano 2020; Graziano *et al.* 2020) especially the portrayal of the seer as just a schema to aid in attention does not fit with the YTC but the generation of schemas of attention as a modulation integrates well with YTC.

Limitations of YTC

YTC as a theory does not focus on the phenomenology aspect of consciousness. All conscious percepts are considered as contents of mind derived from the sense organs with specific 'tanmatras'. The theory also does not consider aspects of affect and emotion.

Conclusions

We present a neuroscientific perspective of the YTC as presented in the yoga sutras of Patanjali and the 'Sankhya' philosophy. From the first person perspective, reality is classified as 'Purusha' and 'Prakriti' [composed of the ego, mind, intellect, sense organs, action organs, subtle sense dimensions ('tanmatras') and elements]. The 'Purusha' is the seer or self or the consciousness, and the mind interacts with the world through the organs of action and perception. We present that the development of the mind depends on the number and type of sense and action organs and the 'tanmatras' (sensory specificity) which can allow us to better model mind and consciousness of other species. We also suggest that species specific findings may not be generalizable.

The mind acts as a gateway to the perceived world for the seer. The mind has modulations like attention, inference, memory, sleep, imagination and wrong knowledge which alter perception, and thus the conscious awareness of the percept. Attentional modulations affect perception and the content of the mind is enhanced at the cost of non-attended stimuli. Active-inference-based modulations affect our sensory signals as well as motor responses. Mind wandering through imagination, wrong knowledge and memory modulates the intrinsic and self-referential processing at the cost of extrinsic modulations and in turn affects consciousness.

The practice of yoga is having a say over these modulations and truly 'perceive' our consciousness. Modern scientific literature on meditation has suggested the presence of unique neurobiological signatures for such states. We elucidate the different states of mind like 'Dhyana', 'Dharana' and 'Samadhi' and characterize them which can help improve current approaches to neuroscience of yoga and meditation. Our specification of the internal and external states of mind can better our understanding of the neural correlates of consciousness.

Our theory is one of the first to integrate the aspects of organization, evolution and development of mind, modulations of mind and how it affects perceptual consciousness, and intrinsic states of meditation in a cohesive structure. YTC is an overarching theory and works in conjunction with the current neuroscientific theories of consciousness which addresses specific parts of the understanding of mind and consciousness.

Box 4: Glossary

'Sankhya': Enumerationist Indian philosophical system which breaks down the reality in its constituent parts.

'Yoga': Indian philosophical school associated with the practice of achieving enlightenment and taking over the illusion of the mind relation with the scenery.

'Tanmatras': Subtle sense organs which can be thought of the combination of range of each sense organ in terms of physical reality it captures (for a species) and the specificity of sense organs (for each individual).

'Mann/Manas': Mind.

'Buddhi': Intellect, an individualized abstraction of Mahat which is the intelligence of the nature.

'Ahankara': Ego sense which gives the illusion of separation of one individual from the other.

'Samadhi': State of equanimity with or without perception.

'Samapatti': State of equanimity with perception.

'Chitta': Individualized consciousness comprising the intellect, ego, mind and memory.

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Conflict of interest statement

None declared.

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