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Looking into Measures of Consciousness*

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SUMMARY

Consciousness is an abstract concept which has been described in many ways since time immemorial. Ancient Hindu scriptures describe consciousness as Chitta which is derived from Chetna, the life force. The Chitta has several forms and stages named as Vrittis. Yoga is good control over the vrittis. There are five vrittis, Praman (Logical state), Viparyay (confused state), Vikalpa (pros and cons state), Nidra (deep sleep state) and Smriti (memory state), each having positive aspect and negative aspect. One attribute of the GOD is Satchidananda meaning truly conscious bliss, describing ultimate bliss as the highest level of consciousness.

In the modern context the consciousness is described as the quality or state of being aware of an external object or something within oneself. It may have several stages such as the wakeful state, the dreaming state and the deep sleep state. One can be made unconscious by administering anesthesia inducing drugs. Anesthesia is the condition of having sensation, feeling of pain blocked or temporarily taken away. In medical terminology, anesthesia is a pharmacologically induced and reversible state of amnesia, analgesia, loss of responsiveness, loss of skeletal muscle reflexes, decreased stress response, or all of these simultaneously. This allows patients to undergo surgery and other procedures without the distress and pain they would otherwise experience.

Measuring Consciousness, along with the consciousness levels and the consciousness content has been a subject for research in medical sciences as well as in behavioral/psychological sciences. Attempts have been made to understand biological and psychological information present in consciousness by determining the neuro-physiological and psychological correlates of consciousness. There are three approaches to developing measure of consciousness. Medical approach is to compare the physical mental processes involved in conscious beings as opposed to those of unconscious beings and also all the intervening subconscious states between these two extremes. Behavioral approach is to observe response of a person to given stimuli and develop a behavioural measure of consciousness based there upon. The third approach is by the computer scientists to develop artificial machine consciousness in the present day computers as an extension of artificial intelligence. Measuring consciousness involves measuring the consciousness level and the consciousness content beyond the zero-point of unconsciousness. Hawkins demonstrated the use of kinesiology by measuring muscle response to specified stimuli for measuring different levels of consciousness in an individual.

In developing measures of consciousness, the statisticians have so far played a limited role. The purpose of this article is to encourage and stimulate the agricultural statistician/informatics fraternity for contributing to a very interesting and upcoming branch of study such as measuring consciousness.

1. INTRODUCTION

At the outset I would like to express my profound gratitude to the Indian Society of Agricultural Statistics for inviting me to deliver Dr. V.G. Panse Memorial Lecture and providing me an opportunity to pay my personal tributes and homage to an Indian legend in agricultural statistics, late Dr. Vinayak Govind Panse, Statistical Advisor to the Indian Council of Agricultural Research, Union Ministry of Agriculture, Govt. of India

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for a continuous period of 15 years and the one who was responsible for shaping the destiny of agricultural statistics in India through formation of this society of agricultural statistics (he was one of the 10 founding members) and developing and nurturing an institution of agricultural statistics which is now known as Indian Agricultural Statistics Research Institute, New Delhi. Though I did not have a direct opportunity of having personal association with late Dr. V.G. Panse, yet I feel proud of having studied for my master and doctoral degrees from an institution that he was responsible for visioning, planning, establishing and nurturing. I also had an opportunity of serving the same institution as Director over a period of more than 10 years. Accordingly I would like to pay by humble tributes to the legendry visionary agricultural statistician that late Dr. V.G. Panse has been, as a source of strength and torch bearer in the field.

In view of my current affiliation, I would like to choose to speak on an abstract conceptual entity, the consciousness. The term 'Consciousness' stands for being aware of one's surroundings and, at a deeper level, of being aware of one's own inner self. Merriam-Webster dictionary defines consciousness as the quality or state of being aware of an external object or something within oneself. Human consciousness is a mystery that has occupied the minds of great thinkers for centuries, from philosophers who have puzzled over the nature of the mind to the biologists trying to figure out how a network of neurons can work together to create self-awareness. The mind/body problem, as famously pondered by the philosopher René Descartes, defines the mind - with which we perceive sensation - as the qualia, a completely separate entity from the body. This dichotomy between physical body and intangible mind makes consciousness extremely difficult to study. There is a theory of reductionism which does not recognize the existence of mind as a subjective, private sense-data construct and considers all mental activities as specific neural states of the brain (Buttazzo 2001) and therefore, any activity that occurs in the brain is physically observable. A third school of thought called idealism rejects the physical world as being anything other than mental constructions. In this case, even the tangible things are immeasurable, as they exist in the individual's own perception of things around him. However, at the heart of scientific studies are judicious observations and measurements. There is a saying that what can be measured has a much better chance of being understood by us than does something that can only be argued about. But how can consciousness—an ineffable and ethereal entity which can't even be rigorously defined—be measured? Consciousness had been viewed with skepticism over the years, but of late it has become a significant topic of research in psychology, neuroscience and computer science. Measuring consciousness, a conceptual entity involving one's behavior (psychological) and associated physical, mental, neuro-physiological processes is now an important problem in psychometrics.

As we commonly understand by consciousness, it is being aware of the surroundings. We distinguish different types/levels of consciousness in general parlance. A conscious mind is the one which is aware of the surroundings as to what it is doing, seeing, perceiving etc. On the other hand, the unconscious mind is not aware of the surroundings as if it is in deep sleep, coma etc. The sub-conscious mind is not being fully aware of the surroundings but there is some amount of perception, dreaming, etc. a kind of in-between situation between consciousness and unconsciousness. There is another level known as pre-conscious mind is a level just prior to being conscious, the feelings, the emotions etc. Lastly, there is the sharp intellectual state (Prakhar Pragya), the spiritual consciousness, the super conscious mind which is the highest level of perception. Authors have represented such levels in many ways: (images obtained from internet sources)

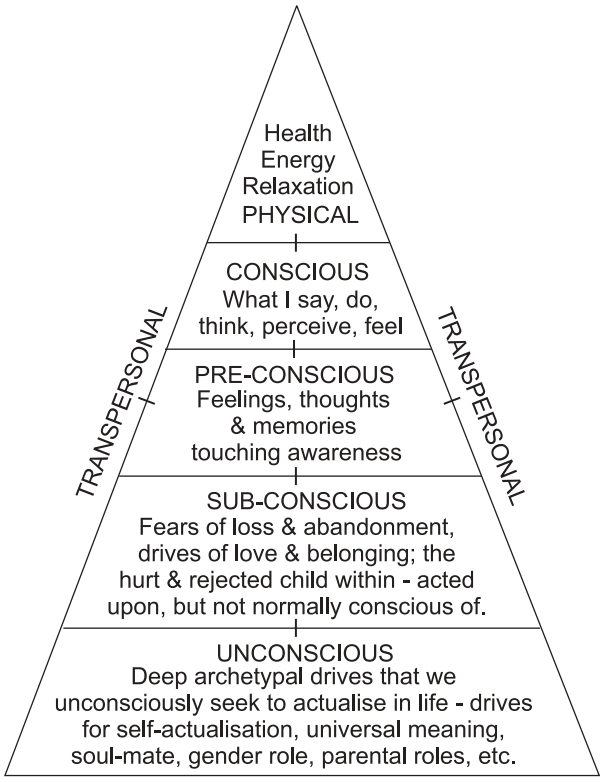

Fig. 1

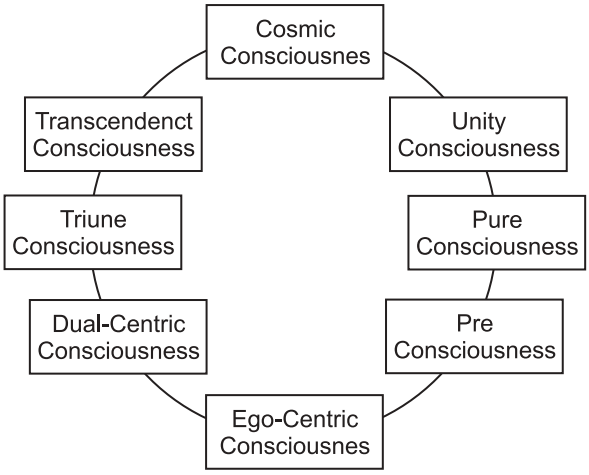

Fig. 2

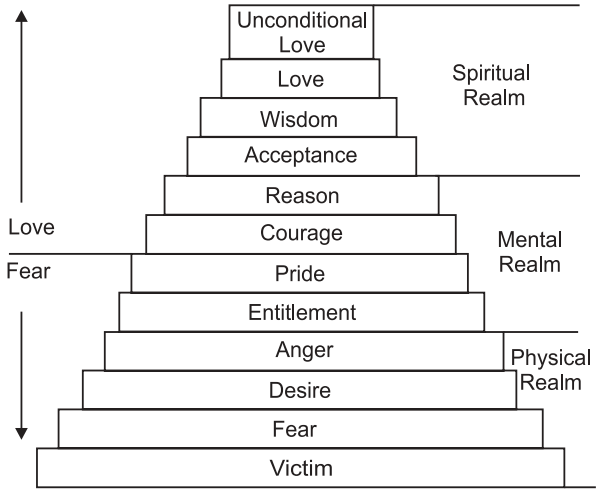

Fig. 3

2. CONSCIOUSNESS AS ENUNCIATED IN HINDU SCRIPTURES

Ancient Hindu scriptures describe consciousness as Chitta which is derived from Chetna, the life force. The Chitta has several forms and stages named as Vrittis. The first chapter of Patanjali Yoga Sutra known as Samadhi Pada has the following few verses.

योगश्चित्तवृत्तिनिरोधः ।।२।।

तदा द्रष्टुः स्वरूपेऽवस्थानम् ।।३।।

वृत्तिसारूप्यम् इतरत्र ।।४।।

वृत्तयः पञ्चतय्यः क्लिष्टाः अक्लिष्टाः ।।५।।

प्रमाणविपर्ययविकल्पनिद्रास्मृतयः ।।६।।

It says that yoga is nothing but good control over the vrittis. When one has good control over vrittis, one can visualize the true inner self. Otherwise one behaves in accordance with the specific vritti. There are five vrittis, Praman (Logical state), Viparyay (confused state), Vikalpa (pros and cons state), Nidra (deep sleep state) and Smriti (memory state), each having positive aspect and negative aspect. Chitta coming from Chaitanya is consciousness. Vrutti is the level of consciousness. Thus as per Patanjali Yog Sutra there are 5 desirable consciousness levels and 5 undesirable levels. Five levels are the logical state (Pramana), the confused State (Viparyaya), the brooding over pros and cons (Vikalpa), the deep sleep –unconscious (nidra) and the memory state (Smrutayah). Each of these has positive (desirable) aspect and the negative (undesirable) aspect. For instance, in the logical state, the desirable aspect could be the positive arguments in trying to analyze and understand a concept rather than to analyze just for the sake of criticism and deriding opponents and so on. When all these ten levels of vrittis are controlled and are in positive state, one realizes the real meaning of oneself, which is "Svaroop" and which ushers in the state of bliss. In Hindu scriptures, one attribute of the GOD is 'Satchidananda' meaning truly conscious bliss, describing ultimate bliss as the highest level, spiritual consciousness. In meditation/yoga it is possible to have this experience of eternal bliss known as Samadhi, where there is inner alertness but no object of consciousness.

There is another concept of five coverings (sheaths) of the body which one needs to transcend step by step. These five (Panch) sheaths (Kosha) describe the states of consciousness, involving a spiritual journey from outwardly physical realm to the inwardly subtle realm to the further deeper inner causal realm and to a still further deeper, intellect realm and ultimately to the blissful realm. The Annamaya kosha (those physical aspects of body which require nourishment through food), the Pranmaya kosha (vital breathings supplying energy to the physical body), the Manomaya kosha (those aspects which arise in mind such as sankalpa, vikalpa, emotional aspects etc.), the Vignyanmaya kosha (mental, reflective thought, contemplation aspects) and Aanandmaya kosha (blissful state). It is described in "Gayatri ki panch koshi sadhna evam uplabdhiyan"- Pt. Shriram Sharma Acharya Vangmay-13. Renowned spiritual psychologist David Hawkins who introduced the measure for human consciousness mentions a similar concept, "*At some point, the illusion breaks down and the opening for the start of the spiritual quest commences. The quest turns from without to within and the search for answers begins*."

3. CONSCIOUSNESS AS DEVELOPED IN MODERN CONTEXT

In the modern context, as stated before, the consciousness is described as the quality or state of being aware of an external object or something within oneself. It may have several stages such as the wakeful state, the dreaming state and the deep sleep state. It is known that one can be made unconscious by administering anesthesia inducing drugs. Anesthesia is the condition where sensation and the feeling of pain is blocked or temporarily taken away. In medical terminology, anesthesia is a pharmacologically induced and reversible state of amnesia, analgesia, loss of responsiveness, loss of skeletal muscle reflexes, decreased stress response, or all of these simultaneously. This allows patients to undergo surgery and other procedures without the distress and pain they would otherwise experience.

Measuring Consciousness, along with the consciousness levels and the consciousness content has been a subject for research in medical sciences as well as in behavioral/psychological sciences. Attempts have been made to understand biological and psychological information present in consciousness—that is, on determining the neuro-physiological and psychological correlates of consciousness. Science of understanding the conceptual entity of consciousness has progressed considerably along with developing various measures of consciousness. There are three approaches to developing measure of consciousness. Medical approach is to compare the physical mental processes involved in conscious beings as opposed to those of unconscious beings and also all the intervening subconscious states between these two extremes. Behavioral approach is to observe response of a person to given stimuli and develop a behavioural measure of consciousness based thereupon. The third approach is by the computer scientists to develop artificial/machine consciousness in the present day computers as an extension of artificial intelligence. Generally, there are two aspects of measuring consciousness, namely the conscious level and the conscious content beyond the zero-point of unconsciousness. However, there are certain phenomena such as subliminal perception, blind-sight, denial of impairment, and altered states of consciousness produced by psychoactive drugs or the spiritual/meditative techniques which requires deeper study into the nature of consciousness.

Brain lesions are the damaged portion of brain. Brain is the most important organ in the body, responsible for the unconscious autonomic activities like breathing, blood pressure and temperature control, sensation, movement, and thought processes. Brain comprises of neurons (active nerve cells - 100 billion) and glia (non active non-nerve cells - 1000 billion) with each area of brain responsible for specific brain function. Different areas of brain control different body functions. A brain lesion is an area of damaged brain which may be isolated or many areas affected. Symptoms of a brain lesion depend upon what part of the brain is affected. Brain lesions can result from many factors, including vascular disorders, traumatic brain injuries, and tumors. Brain lesions affect consciousness and the overall personality to a considerable extent.

Subliminal (or unconscious) perception refers to the idea that stimuli presented below the threshold for conscious awareness can influence an individual's thoughts, feelings, or actions and is linked to the mind control where an individual/ group can be made to react to a stimuli in a certain desired manner without individual/group being conscious/aware. Thus the behavior of individuals can be controlled and manipulated and they can be made to do things which normally they would not do.

Blindsight- Subjects having damaged visual cortices and reporting blindness, when prompted, could guess with above-average accuracy the presence/details of objects not actually seen by them. Though blind patients report an inability to see objects, but when asked to guess at their location they display a capacity to point at them with reasonable accuracy. The phenomenon, called "blindsight", is the evidence that being aware of doing something is distinguishable from doing something, and that the areas of the brain underlying the experience of doing at least some things are distinct from those needed to actually do those things. Such a dissociation provides evidence for the existence of an "unconscious" as a contributor to human behavior and also "consciousness" as distinctive part rather than synonymous with the totality of brain function. Though blindsight occurs only in cases of brain damage, but it is a significant phenomenon of intact brain function as well where one wants to move quickly and appropriately, without "thinking about it".

4. PRIMARY SENSORY CONSCIOUSNESS

Primary consciousness is the ability to integrate observed events with memory to create an awareness of the present and immediate past including subjective sensory contents of consciousness such as sensations, perceptions, and mental images. Primary consciousness, thus, refers to being mentally aware of things in the world in the present without any sense of past and future; it is composed of mental images bound to a time around the measurable present. On the other hand, higher order consciousness is described as being "conscious of being conscious"; it is accompanied by reflective thought and includes a past as well as speculation about the future. Primary consciousness has two forms, focal awareness and peripheral awareness. Focal awareness encompasses the center of attention, whereas peripheral awareness consists of things outside the center of attention. Edelman's theory (2004) for neurophysiological basis of primary consciousness assumes that

1. Laws of physics apply to consciousness, ruling out concepts such as spirits and soul and allows purely physiological model of consciousness.
2. Consciousness is an evolved characteristic, from a Darwinian perspective.
3. Qualia, the collections of personal or subjective experiences, feelings, and sensations inevitably accompany human awareness.

Edelman's theory focuses on two nervous system organizations: the brainstem and limbic systems on one side and the thalamus and cerebral cortex on the other side. The brain stem and limbic system take care of essential body functioning and survival, while the thalamocortical system receives signals from sensory receptors and sends out signals to voluntary muscles such as those of the arms and legs. The theory asserts that during evolution the connection of these two systems helped animals learn adaptive behaviors. This connection allows past signals related to values set by the limbic-brain stem system and categorized signals from the outside world to be correlated, resulting in memory in conceptual areas. This memory is then linked to the organism's current perception, which results in an awareness of the present, or primary consciousness. In other words, primary consciousness arises from the correlation of conceptual memory to a set of ongoing perceptual categorizations—a "remembered present".

Another view is that primary consciousness might have emerged with the basic vegetative systems of the brain, i.e., the evolutionary origin might have come from sensations and primal emotions arising from sensors and receptors, both internal and surface, signaling that the well-being of the creature was immediately threatened—for example, hunger for air, thirst, hunger, pain, and extreme temperature change. This is based on neurological data showing the thalamic, hippocampal, orbitofrontal, insula, and midbrain sites are the key to consciousness of thirst. These scientists also point out that the cortex might not be as important to primary consciousness as some neuroscientists have believed. Evidence of this lies in the fact that studies show that systematically disabling parts of the cortex in animals does not remove consciousness. Another study found that children born without a cortex are conscious. Instead of cortical mechanisms, these scientists emphasize brainstem mechanisms as essential to consciousness however higher order consciousness does involve the cortex and complex communication between different areas of the brain.

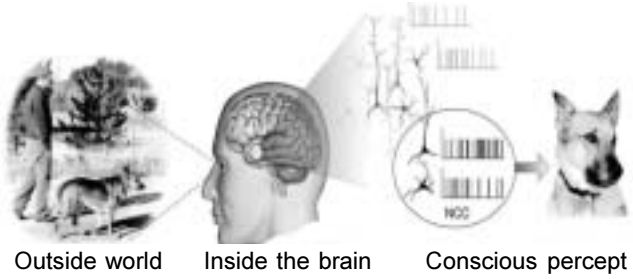

Fig. 4

Neurophysiological basis — Neural Correlates of Consciousness

Three fundamental facts stand out about primary consciousness:

1. Waking consciousness is associated with low amplitude, irregular EEG activity in the 20–70 Hz range. Conversely, unconscious states like deep sleep, coma, general anesthesia, and epileptic states of absence show a predominance of low frequency, high-amplitude and more regular voltages at less than 4 Hz.

2. Consciousness seems to be instinctively associated with the thalamus and cortex. Damage to the brainstem or thalamus can abolish consciousness, while damage to the sensory cortex appears to delete specific conscious features such as color vision, visual motion, conscious experiences of objects and faces, and the like.
3. Consciousness is distinctively associated with widespread brain activation related to the conscious content. Several experiments show that sensory input supporting consciousness spreads from the sensory cortex to parietal, prefrontal, and medial-temporal cortex, while closely matched input that does not reach consciousness activates mainly local sensory regions. Further, the widespread activity appears to involve more globally coordinated activity.

In medical studies, consciousness is assessed by observing a patient's arousal and responsiveness to painful external stimuli, and can be seen as a continuum of states ranging from full alertness and comprehension, through disorientation, delirium, loss of meaningful communication, and finally loss of movements. Peering into the anesthetized brain with neuro-imaging and electro-encephalograph (EEG) recordings, scientists have found evidence to support the integrated-information theory proposed by Tononi (2004) which holds that consciousness relies on communication between different brain areas, and fades as that communication breaks down. EEG studies have also revealed distinctive brain wave patterns that signal when consciousness is lost and regained, offering easily identifiable markers for this impairment of communication. Though many questions remain to be answered, advances in brain activity monitoring promise to shed light on the mechanism of neural basis of consciousness. Such understandings may eradicate the nightmare of mid-surgery awakenings of anesthetized patients.

Consciousness and the cognitive activity depends upon synchronized communication between discrete groups of neurons, both, within the cortex and across brain regions. If different areas of the brain are not in synchronization or if a critical area that normally integrates cognitive activity is not functioning, one could be rendered unconscious. Combining EEG recordings with Transcranial Magnetic Stimulation (TMS), the gradual breakdown of connectivity between neural networks during natural Rapid Eye Movement (REM) sleep and anesthesia, as well as in brain-injured unresponsive patients was measured. Tononi (2004) while working to quantify consciousness argued that it is possible to define consciousness mathematically through posteriori probability distribution and also to measure it by assigning number to any state of awareness. Using a combination of information theory and neuroscience, one can gauge how much consciousness is unfolding inside a brain at any given time. He postulated that consciousness is made of "integrated information"—information that happens to be stored in our neurons. The information is "integrated" because of the complex, hierarchical way in which it is organized: Smaller systems integrate into bigger ones, combining their information to create something that is more than the sum of its parts. The human brain is unequalled in its ability to organize its information in a meaningful integrated way and it is possible to measure the degree of integration, by using a web of electrodes to measure how a brain reacts to an external stimulus, like a magnetic pulse. Tononi uses "ϕ", to represent the integrated information, and measured "ϕ" in different states—awake, asleep, under anesthesia, even in coma through a series of experiments.

5. TONONI'S MEASURE OF INTEGRATED INFORMATION

In order to generate consciousness, a physical system must be able to discriminate among a large repertoire of possible states (representing information) and it must be unified as a single system, one that is not decomposable into a collection of causally independent parts (integration). The information generated when a system is characterized by a certain mechanism, M in a particular state x_i can be measured by the relative entropy (measure of uncertainty) H between the actual and the potential repertoire state ("relative to" is indicated by ||), captured by the effective information, $\phi(X(M, x_1)) = H * p(X_0(M, x_1)|| p(X_0(\text{maximum } H))$. Relative entropy, also known as Kullback-Leibler divergence, is a difference between probability distributions (Cover and Thomas 2006). If the distributions are identical, relative entropy is zero; the more different they are, the higher is the relative entropy. The system's mechanism and state generate information by sharpening the uniform distribution into a less uniform one. The amount of effective information generated by a system is high if it has a large potential repertoire and a small actual repertoire, since a large

number of initial states are ruled out. By contrast, the information generated is little if the system's repertoire is small, or if many states could lead to the current outcome, since few states are ruled out. For instance, if noise dominates (any state could have led to the current one), no alternatives are ruled out, and no information is generated. Since effective information is implicitly specified once a mechanism and state are specified, it can be considered to be an "intrinsic" property of a system. To calculate it explicitly, from an extrinsic perspective, one can perturb the system in all possible ways (*i.e*., try out all possible input states, corresponding to the maximum entropy distribution or potential repertoire) to obtain the forward repertoire of output states given the system's mechanism. Finally one can calculate, integrated information using Bayes' rule, the actual repertoire and the system's state.

However, Tononi's measure does not answer as to how awareness can actually arise from matter yet the approach provides some amount of measure of consciousness in live beings other than human adults.

6. PSYCHOLOGICAL BASIS OF MEASUREMENT

The concept of Level of Consciousness(LOC), and its measurement was introduced by renowned psychiatrist Hawkins (1995). He discusses the natural power of truth and shows that kinesiology can be reliably used to distinguish truth from falsehood. When a person makes a clearly true statement his body produces a strong response as indicated by a muscle test. Stating a falsehood has the opposite, weakening effect. In order to eliminate any element of subjectivity in the demonstration of the effect, a computer driven pressure gauge was used in place of the typical procedure of a person checking the strength or weakness of the muscle.

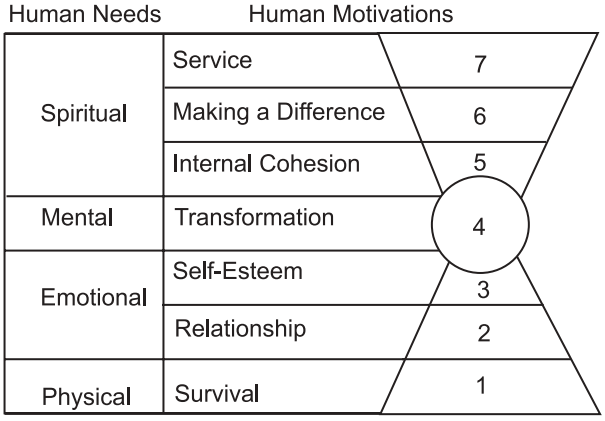

Fig. 5. Seven Levels of Consciousness

Levels of Consciousness

Hawkins applied this same widely used and accepted testing procedure to evaluate the basic underlying motivational level of thousands of people to see how positive, loving, truthful and enlightened they were. His findings are summarized in the form of a consciousness scale giving consciousness values from 0 to 1000 providing several stages of consciousness levels (LOC). Any fundamentally honest person, can learn how to check the strength of a person's muscle responses, (kinesiology).

According to Hawkins' system the average human consciousness on the planet right now is just below 200, yet the collective human consciousness is above this line. This paradox is due to the fact that the people vibrating at a much higher level of consciousness along this scale helps to counterbalance the majority of others vibrating below 200.

The scale advances logarithmically. For instance, one person vibrating at love, which is 500 on the scale, counterbalances 750,000 individuals below the line, while one enlightened person at 700 counterbalances around 70 million others below the line!

Shame to pride scale

Shame (20) – It is just a step above death. This is the consciousness level of one contemplating suicide or thoughts of death. This level can be thought of as self-directed hatred.

Guilt (30) – This is a step above shame, yet perhaps still having thoughts of suicide, and thinking of oneself as a sinner, and unable to forgive oneself for past transgressions.

Apathy (50) – It is the feeling of hopelessness or victimized; the state of learned helplessness. Many homeless people belong to this stage.

Grief (75) – It is a state of perpetual sadness, loss and depression. One might drop down to this stage after losing a loved one.

Fear (100) – It is seeing the world as dangerous and unsafe; paranoia. There is an urgent need to want to rise above this level, or else remain trapped for a long time, such as in an abusive relationship.

Desire (125) – This is the level of addictive desire, craving, and lust- for money, approval, power, and fame, consumerism, materialism, excessive smoking,

drinking, and drug abuse etc. It should not be confused with setting and achieving goals.

Anger (150) – This is the level of strong hate and frustration, often from not having one's desires met at the lower level. This level can spur one to action at higher levels, or it can keep one stuck in hatred.

Pride (175) – This is the first level where one start to feel good, but it is somewhat false feeling as it depends on external circumstances (money, prestige, etc), so it's vulnerable. Yet pride can lead to nationalism, racism, and religious wars. This is often a state of irrational denial and defensiveness; even religious fundamentalism is an example of this level. A person becomes so closely enmeshed in their beliefs that they see an attack on their beliefs as an attack on themselves.

Courage to reason scale

Courage (200) – This is the first level of true strength. This is where one starts to see life as challenging and exciting instead of overwhelming. This level promotes interest in personal growth, such as skill-building, career advancement, and further education. Here a person starts to see their future as an improvement upon their past, rather than a continuation of the same.

Neutrality (250) – This level is epitomized by the phrase, "live and let live." It's flexible, relaxed, and unattached. Whatever happens, there is no need to have anything to prove. One feels safe and easily relating with other people. This is a very comfortable place sometimes promoting a level of complacency and laziness. Here a person is taking care of their needs, but won't push too hard.

Willingness (310) – At this level a persona is safe and comfortable, and can start using their energy more effectively. One begins to take action and thinks about time management, productivity, and getting organized, things that weren't so important at the level of neutrality. This is the level where the development of willpower and self-discipline becomes important. This is the point where one consciousness becomes more organized and disciplined.

Acceptance (350) – This is the level where a powerful shift happens, and one awakens to the possibilities of living proactively. At the level of willingness one becomes competent, and now their abilities are multiplied to good use. This is the level of setting and achieving goals. This level drives many people to switch careers, start a new business, or change their lifestyle.

Reason (400) – At this level one transcends the emotional aspects of the lower levels and begins to think clearly, rationally, and start making meaningful contributions. Hawkins defines this as the level of medicine and science. At the very high end, this is the level of Einstein and Freud.

Love to Enlightenment scale

Love (500) – This is the level of unconditional love, a permanent understanding of one's connectedness with all that exists, a deep sense of compassion. At the level of reason, one is living in service to the mind. At the level of love, one now places their mind and all your other talents and abilities in service to one's heart. This is the level of awakening to one's true purpose. All motives at this level are pure and uncorrupted by the desires of the ego. This is the level of lifetime service to humanity and beginning to feel as being guided by a force greater than oneself. Examples are Gandhi, Mother Teresa, and Dr. Albert Schweitzer. Hawkins claims this level is reached only by 1 in 250 people during their entire lifetimes.

Joy (540) – This is the ultimate state of pervasive, unshakable happiness. This is the level of saints and advanced spiritual teachers. Just being around people at this level makes one feel incredible. At this level life is fully guided by synchronicity and intuition. There is no more need to set goals and make detailed plans - the expansion of your consciousness allows one to operate at a much higher level.

Peace (600) – This is the level of supreme transcendence. Hawkins claims this level is reached only by one person in 10 million.

Enlightenment (700-1000) – This is the highest level of human consciousness, where humanity blends with divinity and is extremely rare. This is the level of Krishna, Buddha, and Jesus. Even to just think and study about people at this level can raise one's consciousness.

These consciousness levels may be summarized below:

Table 1. Hawkins scale of consciousness

Sl No.	Rating	Level	Emotion
1	20	Shame	Humiliation
2	30	Guilt	Blame
3	50	Apathy	Despair
4	75	Grief	Regret
5	100	Fear	Anxiety
6	125	Desire	Hate
7	175	Pride	Scorn
8	200	Neutrality	Trust
9	310	Willingness	Optimism
10	350	Acceptance	Forgiveness
11	400	Reason	nderstanding
12	500	Love	Reverence
13	540	Joy	Bliss
14	600	Bliss	Illumination
15	700-1000	Enlightenment	Ineffable

7. ARTIFICIAL CONSCIOUSNESS - MACHINE CONSCIOUSNESS

Artificial consciousness(AC), also known as machine consciousness (MC) or synthetic consciousness, is a field related to artificial intelligence and cognitive robotics whose aim is to define that which would have to be synthesized were consciousness to be found in an engineered artifact (Aleksander 1995). Neuroscience hypothesizes that consciousness is generated by the interoperation of various parts of the brain, called the neural correlates of consciousness(NCC). Proponents of Artificial Consciousness believe it is possible to construct machines (*e.g.*, computer systems) that can emulate this NCC interoperation.

The most common taxonomy of consciousness is into "access" and "phenomenal" variants. Access consciousness concerns those aspects of experience that are amenable to a functional description, while phenomenal consciousness concerns those aspects of experience that seem to defy functional depiction, instead being characterized qualitatively in terms of "raw feels", "what it is like" or qualia (Block 1997). Weaker versions of AC only require that functional, "access consciousness" be artificially instantiated.

Putnam (1967) defines mental states in terms of causal roles, any system that can instantiate the same pattern of causal roles, regardless of physical constitution, will instantiate the same mental states, including consciousness and thus functional access consciousness can be artificially instantiated. Functional Consciousness underlines that a mental state of a particular type does not depend on its internal constitution, but rather on the way it functions in the system of which it is a part" (Levin 2013). Thus for a functionalist any machine able to perform the tasks, or functions, of consciousness, must be doing so through a form of consciousness itself. Artificial consciousness seems to be an entirely plausible feat to functionalists, assuming that it will be achieved as soon as scientists are able to program machines able to perform the tasks of consciousness.

One can draw an analogy with Turing machine where Alan Turing, essentially a functionalist, developed a system to test consciousness via machine intelligence in 1950. The Turing machine was aimed to determine whether a computer could "think". A machine would be labeled "intelligent" if a human interrogator was unable to tell it apart from another human via a conversation (Harnard, 2008). The fact that Turing created a system to test computers for "intelligence" (a function of consciousness), signifies that Turing not only believed it plausible, but imminent, that artificial consciousness be produced in machines.

Scale of Machine Consciousness: In order to identify various states of consciousness and also to measure consciousness, a scale of Machine consciousness known as ConsScale, has been designed originally for the evaluation of Machine Consciousness implementations. However, it can be potentially applied to any creature – the biological organisms and also the artificial systems. Each level in ConsScale is characterized by architectural and behavioral criteria. Using the *ConsScale* Calculator an artificial agent can be rated and assigned a particular level of consciousness. The specific level attained by an agent indicates the degree of development of consciousness in terms of effective integration of key cognitive functions.

The evaluation performed using *ConsScale* can be also regarded as a measure of the *"Cognitive Power"* of an agent. As the considered cognitive functions are associated with consciousness, the obtained measure is also a measure of consciousness. The higher the level obtained, the more the behavior of the agent resembles that of well-known conscious creatures like humans.

Hawkins Scale of Consciousness: The Hawkins Scale of Consciousness (SOC) represented as ConsScale Quantitative Score (CQS) has possible values range from 0 to 1000 with levels of Consciousness from 1 to 1000. At the low end it describes the worst of the human states, the most miserable and unhappy. At the high end he places the most saintly and the best of the best. All the rest is in between and he has described what the key points are on the SOC. For example, from 100 on down can be found fear, guilt, shame and apathy. At 200 is the beginning of courage to face the truth. This is a crucial point on the SOC, as before reaching that point people are not yet capable of using kinesiology accurately. The Level of Consciousness (LOC) 400 begins the range of reason and science, the realm of the great thinkers. At 500 starts the level of love and the pathway to higher consciousness states such as unconditional love, 540, and more "saintly" states above that. At 600 begins the levels Hawkins refers to as enlightened. Such people may have more than ordinary abilities, perceptions, creativity and experience great happiness independent of their circumstances.

The various ConsScale Cumulative levels (CLS) can be summarized in Table 2 along with ConsScale Quantitative Score (CQS)

Table. 2

ConsScale Cumulative Level (CLS)		Description	ConsScale Quantitative Score (CQS)
L_1		**Decontrolled**	0.00
L_2		**Reactive**	0.18
L_3		**Adaptive**	2.22
L_4		**Attentional**	12.21
L_5		**Executive**	41.23
L_6		**Emotional**	101.08
L_7		**Self-Conscious**	200.03
L_8		**Empathic**	341.45
L_9		**Social**	524.54
L_{10}		**Human-Like**	745.74
L_{11}		**Super-Conscious**	1000.00

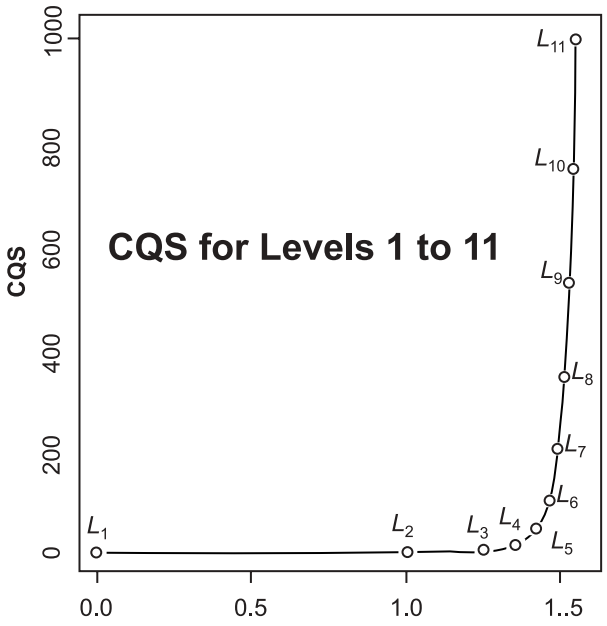

Fig. 6

The CQS curve depicted in Fig. 6 spans from 0 to 1000 in an exponential fashion, representing the cumulative synergy produced by the addition and integration of cognitive features, level after level. As the perceived overall cognitive performance increases, the score also increases exponentially, providing significant values from levels 4 and 5 upwards.

The Fig. 7 summarizes the main Cumulative Conscious levels defined in *ConsScale*. These

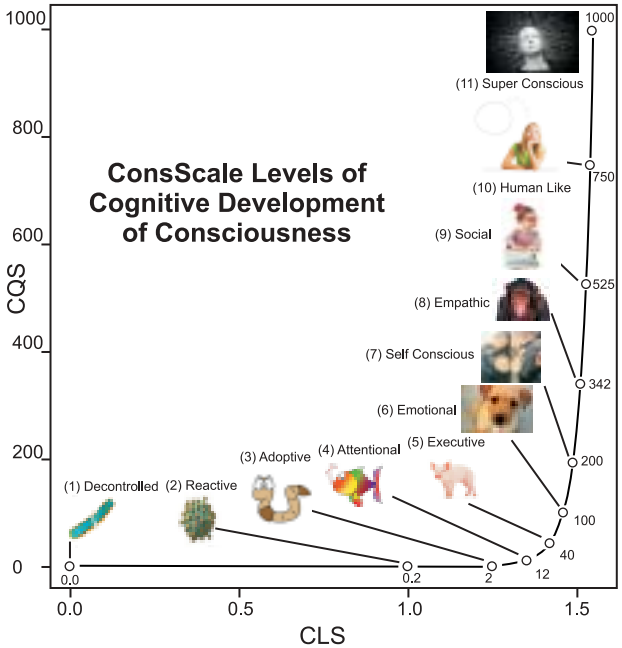

Fig. 7

development milestones are referenced associated with biological analogies. ConsScale not only assigns a particular level, but also precisely establishes the degree of development (which could fall anywhere in between two canonical levels).

In Fig. 7, CQS is represented on the Y-axis whereas the Cumulative Conscious Level Stage (CLS) is on the X-axis. *ConsScale* is an implementation-independent scale and thus it enables comparative analysis of different intelligent/conscious creatures.

According to Hawkins, people are born at a level at which they are likely to stay in their entire life, however, sudden, dramatic shifts upwards may occur as a result of peak experiences, near death experiences or other spiritual, mystic or revelatory experiences. Behavioral scientist Brenner (2009) developed a method to raise the Level of Consciousness (LOC) of most people by as much as 100 points or more in a single session through guided counseling.

8. MEASURES OF CONSCIOUSNESS

Consciousness measurement uses kinesiology which is known to be affected by psychological reversal/switching. Nutritionists, herbalists, acupuncturists, naturopaths, psychiatrists, psychologists and others have been using kinesiology to obtain information about the body/mind for healthy functioning. However sometimes people give strong responses when they should be giving weak ones or giving weak responses when they should be giving strong ones, the phenomenon being known as psychological reversal/switching. A variety of physical procedures have been employed to fix switching before kinesiology testing could resume. Callahan (1985) while discovering a phobia cure that required kinesiology, developed a temporary solution for psychological reversal/switching, which was linked with low self esteem tendencies usually occurring at unconscious level. As a long term correction for the psychological reversal, Brenner (2009) noticed that raising self-esteem sufficiently, resulted in remission from severe auto-immune disorders. His methodology was based on correcting subconscious beliefs, motivations and other mechanisms which raised self-esteem resulting in large increases of LOC.

Comprehensive measure of consciousness must not only define and distinguish between conscious and unconscious states, but must also provide indicators of conscious level and the content of consciousness. There are several theories put forth in this regard.

- Worldly discrimination theory (WDT) asserts that consciousness content directly expressed in any behavior is the content of a conscious mental state; if a person shows that he is consciously aware of a feature in the world when he can discriminate it with choice behavior. This theory makes use of signal detection theory (SDT), a statistical framework for quantifying the discriminability of a stimulus. If over many trials a person can reliably indicate that a certain stimulus was present or not, to any degree above chance, then the information allowing that discrimination must be conscious, on WDT. Though this theory captures choice behavior property of conscious knowledge, yet, it does not account for other consciousness properties such as blindsight etc.
- Integration theories asserts that conscious contents are widely available to many cognitive and/or neural processes. It focuses on finding a divide between conscious and unconscious processes. According to dynamic core and integrated information theories, a mental state is conscious if it provides a sufficiently informative discrimination among a large repertoire of possible states, where successful discrimination requires both differentiation and integration.
- According to higher-order thought (HOT) theories, a mental state is conscious when we are aware of being in that state. Thus a mental state is conscious yet, the person is not aware of being in that state. HOT theories differ from WDT in that it is the ability to tell the mental state one is in, rather than what state the world is in, that determines whether a mental state is conscious.

These theories are then accompanied with measures of the level of consciousness, which are subdivided into behavioral measures and physiological measures.

Behavioral measures

An objective measure refers to the ability to choose accurately under forced choice conditions. In behavioral measures, knowledge is unconscious if it expresses itself in an indirect test, e.g., the ability to pick which item might come next in a series indicating

unconscious knowledge of regularities in sequences. Strategic control measures use a person's ability to deliberately use or not use knowledge according to instructions. If they use information despite intentions not to use it, it indicates unconscious knowledge.

Physiological measures

- Event-related cortical potentials (ERPs) have been used to assess whether a stimulus is consciously perceived or not. These measures either float free of theory, gaining credibility through reliable correlation, or assume a version of integration theory in which the appearance of a particular ERP indicates global availability or locally recurrent processing. Abundant evidence indicates that consciously perceived inputs elicit widespread brain activation, as compared with inputs that do not reach consciousness.
- Dynamic core hypothesis (DCH) proposes that consciousness arises from neural dynamics in the thalamocortical system, as measured by an information-theoretic measure, the quantity neural complexity (CN). The *CN* value is high if each subset of a neural system can take on many different states, and if these states make a difference to the rest of the system.
- Information integration theory of consciousness (IITC) shares with the DCH the idea that conscious experiences provide informative discriminations among a vast repertoire of possible experiences. In the IITC, the quantity *phi* is defined as the information that is integrated across the informational "weakest link" of a system. *Phi* is a measure of the capacity of a neural system to integrate information, whereas *CN* is a measure of the actual dynamics of the system.
- A third measure, causal density *(CD)*, measures the fraction of causal interactions among elements of a system that are statistically significant.

Although behavioral subjective measures are mostly used for assessing which contents are conscious, brain-based objective measures seem better suited for measuring conscious level. However, objective measures require a response criterion, e.g., the decision of whether or not to push a button. Also they may not even measure consciousness because many behavioral proxies, such as forced-choice decision accuracy, are capable of being learned unconsciously. A review of current approaches for measuring consciousness, covering both behavioural measures and measures based on neurophysiological approaches is provided in by Seth *et al.* (2008).

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