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Consciousness, Cognition and Behavior

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ABSTRACT

The readers and authors of the journal are all neuroscientists. The purpose of such review in this journal is to make them familiar with an emerging worldview that the brain is not the source of consciousness and cognitive faculty could not be localised within the specifics of the brain. Further, the relationship between consciousness, cognition and behavior are not horizontal but vertical in time involving nature's prequantum, pre-prequantum nests and the decision-making nest of consciousness. This calls for a cautious interpretation of neuroimaging data in the context of consciousness for management of neurological, psychiatric and psychological diseases.

Method: The review is based upon author's extensive publications on the emerging worldview of a neuraxis which because of ontological reversal works like an inverted tree with roots up, open to depths of the nature and the branches down as peripheral nerves. This view has been extended to build up the idea that systems psyche works as an interphase between brain-bound and brain-independent consciousness, supported by data from some recent publications. The ways have been carved out with innovative ideas and figures how systems cosmology could be connected with systems neuroscience including molecular cell biology.

The Message: Neuroscience needs an overhaul. The classical and quantum neuroscience will find its precise place with development of science of prequantum vacuum having event-generating entity with several information states and memory, followed by a science of sub-subquantum nests of nature, having sentient and homeostasis-running entities; entities are autonomous, however guided by 'will' and intention sourced from the nest of consciousness.

Conclusion: Consciousness cognition and behavior operate on vertical timeline involving different depths of nature and corresponding information states. Intelligence requires involvement of sentient entity, 'life' and 'will', and for behavioral expression, a 'mind' operating through an expressive infrastructure such as brain. Artificial intelligence and artificial brain are relevant in life-less science but are not the determinants of the future of science or humanity. Conclusion remains open-ended till Deep Science confirms the view that a consciousness-rooted neuroscience of live brain is more powerful, and is determinant of the rest of the science.

Keywords: Supracortical consciousness, Cognition, Cognitive faculty, Cognitive currency, Behavior, Attitude, Brain-as-sensor, Heart-as-sensor, Leadership, Deep Science

INTRODUCTION

We begin with the statement that the organ brain supports activities related to consciousness, cognition and behavior. Much have been said on these three vast issues, and also about their neurological substrates. In this paper we would inject some new insights and build up an alternative perspective, which has incredible potential for translational research. Surely, this would take human beings, the biological Homo sapiens, out of evolutionary cul-de-sac, which has been created by a false assumption of cognitive closure of the brain and taking it for granted that the evolution of the brain as an organ has come to a halt. The plan of this paper is first to project accurately the interrelationship of consciousness, cognition and behavior,

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followed by a brief discussion on each of consciousness, cognition and behavior. We would identify and narrate several contexts where the brain is in action. We will have a brief discussion on the brain and heart as sensor of behavior. At the end, we would wind up with concluding remarks and perspectives.

Interrelation of Consciousness Cognition and Behavior

One of the functions of consciousness is cognition. Cognition covers the entire spectrum from perception to action. Cognition, therefore, expresses its effect in behavior of the systems. Cognition alters behavior. Behavior shapes cognitive apparatus and brain. Are consciousness, cognition and behavior connected in circularity? Not in circularity of flatland! This is a circularity in vertical time. Investigation of this interrelationship requires Deep Science. Consciousness from depth feeds forward the process of cognition. Cognition, in turn, feeds forward expression of behavior in a sensible way. There are feedback loops from the altered behavior vertically back to the cognitive organs, which in turn vertically feeds back consciousness **(Figure 1)**. Feed forward loop is a unique characteristic of the living state, where life manages homeostasis by such loops. This kind of vertically feeding forward with information is not observed in absence of life. Such effects of feeding forward are explained from the material perspective as retro-causality! If we divide consciousness-nature spectrum into five nests, consciousness operates from the depth, the nest V. Cognitive activities are in nests IV and III. Behavior is observed in nest II (as micro-events) and nest I (as macro-events). Clarification of this nested hierarchy would appear as we proceed on the paper.

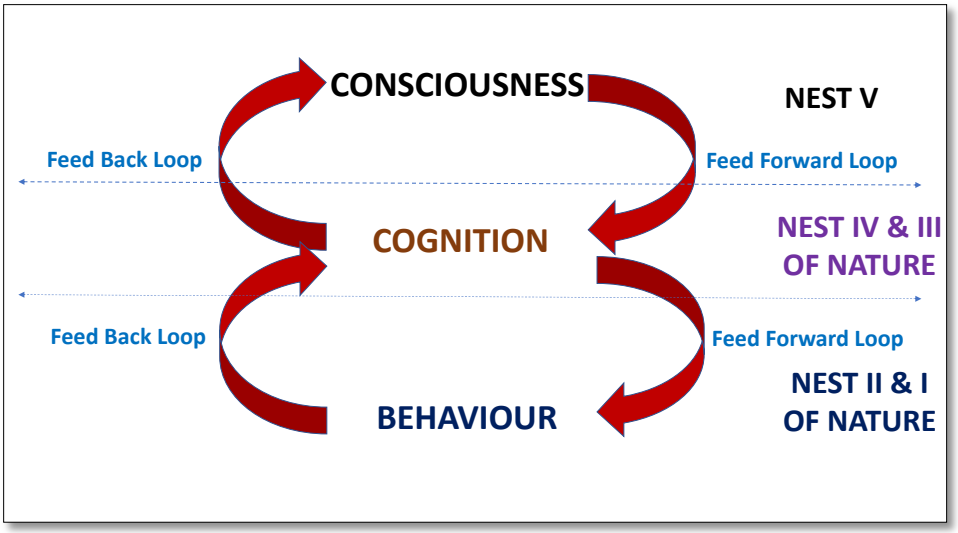

Figure 1. Consciousness, cognition and behavior are connected in vertical timeline with feed forward and feedback control loops. Consciousness operates from nest V, Cognitive activities are in nests IV and III, while behavior is observed in nests II and I of nature-consciousness.

Consciousness

Consciousness is said to be the last frontier of all science and is considered as the ground without any background.

Consciousness and Ether

The imaginary inactive inert "Ether" of physical science has been replaced in the science for consciousness by a willful, intentional, sentient, event-making and live ground without any further background. Carl Jung in 1935, stated psychology as "the science of consciousness." LaViolette [1] had been very close to psychology while he put forward the properties of the three basic substrates in Etheron, in the transmuting ether! In the science of consciousness, this etheron, the transmuting ether, or simply ether itself is consciousness. What are then these three substrates? The substrate with sentient property is the self of cognitive psychology! Feed forward (retro-causality from material perspectives) loop is characteristic of presence of life-operation. This could be the second substrate, which has the ability to run homeostasis through such control loops! Event-making substrate could be what in cognitive psychology called mind! Without operation of mind there is no generation of event from consciousness! Three substrates of etheron (consciousness), therefore, in terminology of cognitive science are self, life and mind **(Figure 2)**! Like protoplasm of material science, one could look for "psychoplasm" in the context of psyche, which is nothing but the ground consciousness!

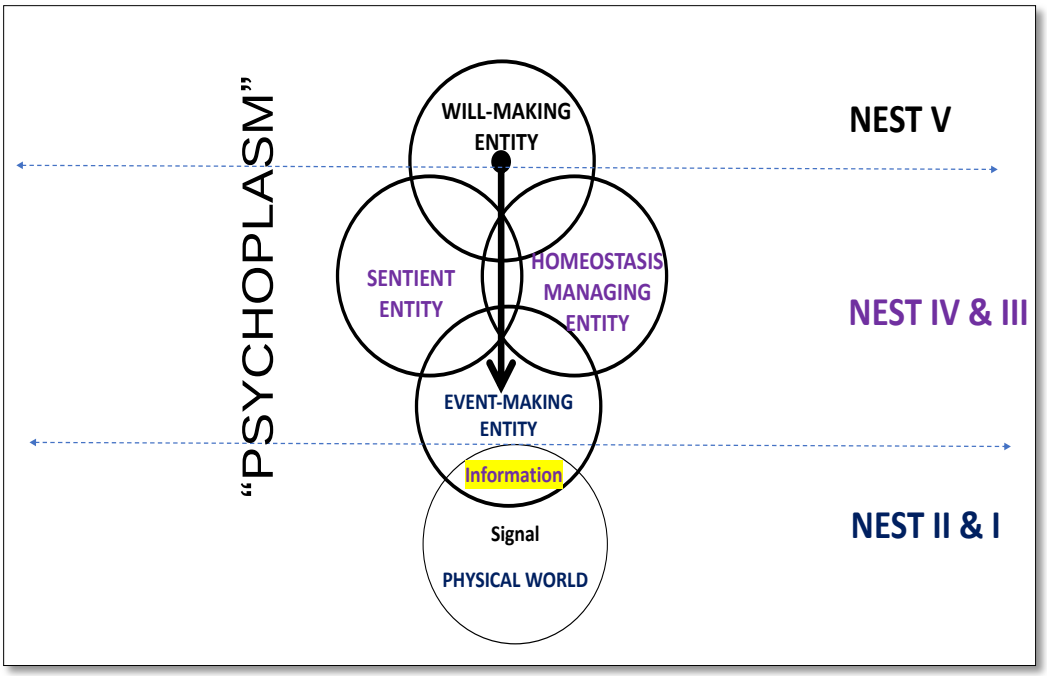

Figure 2. The "psychoplasm", the ground consciousness in the context of the psyche, has properties of making will and intention. Three other substrates are entity with sentient property (self), entity with event-making property (mind) and the entropy-stabilizing entity with ability to run the homeostasis (life) through feed forward (materialistically interpreted as retrocausal) and feedback loops.

TOWARDS SCIENCE OF CONSCIOUSNESS

Building a science for consciousness is difficult. Uta Frith, Emeritus Professor at the Institute of Cognitive Neuroscience, University college of London says that "It is not rocket science. It is a lot harder than that". Mother of Sri Aurobindo Ashram said, "Consciousness is so soft, yet so hard"! Consciousness is unfathomable, the infinity penetrating and emerging through silence, stillness, emptiness and nothingness (in the language of Sri Aurobindo). To extend the present material science of quantum physics vertically to this Infinity one requires (i) a sub-quantum or pre-quantum science (of event-making mind, information, thought and memory), (ii) a sub-subquantum or pre-pre-quantum science (of emotion and intelligence, sentient 'self' and entropy stabilizing homeostasis-running 'life') and finally, (iii) a science *of* consciousness itself! A lot of work has been done on subquantum science by Adrian Klein [2]. The three relevant issues which crop up with consciousness are its (i) working definition (ii) functions/operations which could be investigated, and (iii) source.

Working definition of Consciousness

Consciousness could be defined for practical purpose from ontological, epistemological, phenomenological and axiological perspectives [3].

Consciousness is that which looks after what all have been happening in our (system's) mind, self and life in terms of quality management of information. This definition of consciousness is from ontological point of view. Consciousness here is the MD (Managing Director) directing the cognitive faculty. If quality management of information is discounted from the scenario, it becomes redundant and there is no need of a science for such consciousness. We indeed are talking here of the systems psyche [4].

Consciousness could be practically looked as the process of sensing of the senses, thinking about thinking, feeling about feelings, becoming aware of awareness, intuiting about intuition. Consciousness is the "I" taking care of me and mine. There is endless recursive processes bootstrapping layers after layers, which exist between neural signal and consciousness. This definition of consciousness is from epistemological point of view.

Consciousness by nature is phenomenal and is the source of all phenomena. Consciousness is the center of all phenomenology in nature; surface phenomenology (at classical level, nest I, and quantum level, nest II of nature), elementary phenomenology (of mind, information, memory and thoughts at sub-quantum nest, nest III of nature) and depth phenomenology (of emotion and intelligence involving self and life in sub-sub-quantum nest, nest IV of nature, and of awakening

awareness, choice and decision involving self, life and consciousness). Consciousness creates phenomena which eventually become sensible as organized events. Consciousness regulates, modulates, changes and manages phenomena. All phenomena are absolved by consciousness, absolved in consciousness. This is a definition of consciousness from phenomenological point of view.

Consciousness is conscience from which generate aesthetics and ethics, which support values that uphold the visible laws and rules sensibly. This is a working definition of consciousness from axiological, judicial point of view. From behavioral point of view, consciousness is the sensor and censuring agent for overall projected attitude in the behavior of the person. The attitude emanates from collective play of conscience, ethics, aesthetics and values.

Consciousness is not an oxymoron. It does not accommodate all kinds of opposite pairs to generate a single effect. That happens within a conscious system downstream far below consciousness's own ontological domain.

Consciousness and conscious experience are different. How? Consciousness is diffuse, abstract and without boundary. Conscious experience is particulate, concrete and confined within the boundary of the system. Consciousness could be system-bound or system-independent. Conscious experience is always a systems property.

Operations of Consciousness

What does this nonlocal consciousness do? Science is interested in epistemic consciousness, in what all operations consciousness is engaged to show its observable effect in system's behavior. Textbook teaches three functions of consciousness as cognition, emotion/feeling and will.

Why this operational consciousness is relevant in science? Because, the operation of consciousness couples with operations of other cognitive faculty using cognitive currency of several information-states, and in this way consciousness remains connected with the operational mechanics of the material nature, namely quantum mechanics and classical mechanics.

Following is the list of performances attributed to consciousness which, although operationally non-observable, could be understood at the observable behavioral level.

1. There are operations of consciousness confined to, and related to it.

(i) Maintaining its own absolute self-independence, and

(ii) Hiding itself at depth of the scenario.

2. Consciousness supports the operation conducted by members of the system psyche such as mind, self, and life, and sustains their autonomy.

3. Consciousness participates with the constituent members of the cognitive organ. The change of perception of quantity into a perception of quality cannot happen without intervention of consciousness! No other option exists which could reduce a number of (quantity) spheres in information manifolds into a point of wisdom (quality), and vice versa! Consciousness excluded, there exists no possibility of sublimation of system-bound experience into a system-independent wisdom. The boundary issue of the system could not be handled without invocation of consciousness's operation!

4. As and when required, consciousness intervenes in the operation of the member-constituents in the systems applying its power of "will", for example when there is a conflict of autonomy amongst its members. Will, a function privy to consciousness itself, is executed within the systems through self. The patient of akinetic mutism who although is conscious, remains completely immovable, because of complete lack of 'will' to move.

5. Consciousness executes three other primary operations of systems-bound consciousness with the help of mind self and life.

(i) Cognition, executed with the help of self and mind, formatted on the basis of reasons.

(ii) Feelings sensed by self, and emotion executed through 'life'.

(iii) Switching over from reasons to feelings/emotion and vice versa is not possible without active involvement of consciousness.

6. Consciousness is the 'quality manager' within the psyche. For those familiar with six sigma approach in technology for detection and elimination of error, the quality of "information" within the brain and the psyche ranges from sigma one (for example, in noise) to sigma six (wisdom, world class quality). This is consciousness which keeps the process error-free within the system's constrain. Another expected goal in lean principles as used in manufacturing technology is "just in time". This demands highest level of perfection in timing without error, mistake or blunder. This lean principle is certainly observed in consciousness-operated intuitive process of wisdom.

7. Consciousness is creative. New creation is considered signature of consciousness. Consciousness creates new system, for example, live systems and self-organizing systems.

8. Consciousness gets engaged in destruction of existing system by programmed death (e.g., Apoptosis of cell-systems) and even in non-systematic death when the environment cannot sustain the systems anymore.

9. No other cognitive faculty has the governing power. Only consciousness has it.

In the context of the neuroscience, when nonlocal consciousness gets localized within the brain, consciousness supports and sustains the group activity of neurons and brings order, coherence and unity. Occasionally, consciousness participates with specific assembly of neurons involving brainstem, thalamus and cerebral cortex as happens during awakening, awareness, experiencing, choice-making and in taking decision with expression of will as volition through pyramidal system supported by extrapyramidal system. Consciousness uses the brain as the research and development (R/D) center for its creativity.

Source of Consciousness

Consciousness is usually studied in relation to the organ brain with an assumption that the brain is the source of consciousness and also with assumption that the brain is the cognitive organ. This approach has made consciousness research neurocentric! There is, however, no unequivocal evidence of consciousness originating from the brain. In this context we will consider the open-ended concept of supracortical consciousness (SCC).

Supracortical Consciousness (SCC)

The term and concept of SCC in neuroscience is the outcome of a Big Idea [5,6] that the source of consciousness is not the brain. The brain cannot generate consciousness, nor can use consciousness. It is consciousness which drives the brain and uses the brain for its manifestation. The Big Idea is, the brain is not the source of cognition. Cognitive faculty and cognitive currency work through the substance of the brain for expression of cognition in behavior. The idea comes out of ontological reversal! The Power is not with the brain but with consciousness! Resulting in an astounding new Worldview!

SCC reconciliates difficult divides as exist between brain-bound consciousness and brain-independent Consciousness, left-brain consciousness and right brain consciousness, rational and intuition, evolution and creation, life and after-life, science and mysticism, and between the privileged and the underprivileged of the society! Since the big idea of SCC dissolves so many divides, the idea is revolutionary too!

The vision spontaneously frees us from egocentric, ethnocentric, geocentric and anthropocentric approach to consciousness and makes us cosmocentric and numinocentric (using the words of Ken Wilber) [7]. Hitherto flatland approach to consciousness and behavior is thus replaced by the verticality of Time in event production. This is an invitation for doing a Deep Science! Consciousness operates from nest V, cognitive activities are operated from nests IV and III, while behavior is observed in nest II and I of nature-consciousness canvas.

Consciousness, in general, is undifferentiated, unconditional and nonlocal in nature. Since such consciousness is not in any specific relation or any context with anyone or anything, it usually remains actively standstill, actively inactive!

When such consciousness is to manifest in specific relation to and in the context of the organ brain, nonlocal consciousness becomes 'local', i.e., it gets localized, occupies a supervening position on signaling neurons, and executes its operation on the anatomical brain. In such a situation, in what else better way can we designate this localized and contextualised operational consciousness other than by naming it as supracortical consciousness? An event horizon thus exists at the circumcerebral boundary of the brain for higher order cognition and behavior.

This kind of Top-down idea was with Aristotle saying, "Mind is attached to the brain", also found in ideas like, the radio reception theory of consciousness of Henri Bergson, brain as a biological reducing valve of Aldous Huxley, television analogy of brain function by George Wald and transmission theory of brain function by William James. According to Indian sacred scriptures such as Bhagavad Gita (chapter/shloka: 15/1) and Upanishad, the human body is like an inverted peepal tree with its roots up, open to eternity and branches down! Supracortical consciousness says our vertical neuraxis is like an inverted tree with roots open 'up', in the depths of nature, and the branches of the tree are nerves going downwards. Here cerebral cortex plays the role of a 'receptor' for different information states, in addition to its conventional role as a processor of information and a perceiver.

There is no evidence that consciousness is generated from the brain! However, there are some evidence that consciousness works on the brain; soft evidence from belief system, cultural practices and artistic expression **(Figure 3)** and in almost all spiritual teachings. If not hard, semisoft evidence come from phenomenological experience **(Figure 4)** of autoscopy, out-of-body experience, experience of flying during deep sleep etc., which all point out that consciousness can move easily freely in and out of the brain. Magnetoencephalographic study has shown alteration of brain consciousness by application of circumcerebral stimulus.

Figure 3. Soft Evidence in support of the reality of supracortical consciousness; upper left fig. showing occasion when faith meets science and event horizon comes into focus, upper right fig. showing a recent American Art, lower right fig. showing a monk writing "OM" on the shaven head of a child in the largest religious congregation of India and lower left fig. showing the view stated by Canadian Neurosurgeon Wilder Penfield.

Figure 4. Phenomenal experiences such as out-of-body experience, autoscopy, experience of flying while sleeping, and near-death experience suggest consciousness could move freely and easily in and out the brain.

Top-down behavioral manifestation of SCC is love, behaviorally expressed as sacrifice for the beloved. SCC is characterized by its inexhaustibility, of course within the cortical limits [5,6].

What could be the mediator of such communication between the roots of an upside-down neural tree and the environment is not yet known. The author has proposed ten possible mechanisms in his book, The Millennium Bridge (2000). The role of neutrino-brain interaction and brain-matter-waves interaction in such communication remain distinct possibilities as the bridge between natural science and matter science.

The important question for neuroscience, what makes consciousness and the brain live-in partners in the terrain of love in operation!

"Who can say what we are?

One or Two, Near or Far?"

"All you write are futile guess!

Simple love, please don't make mess!"

There is an exceptional mutual fondness found between consciousness and the brain. Consciousness and brain are eternal lovers. The brain is a community of 10^{11} neurons each of which possesses the property which

could be responsible for consciousness-philia of the brain. Reciprocally, there is neuron-philia of consciousness too. The reasons ascribed for consciousness-philia of neurons is the specific polarity of the neuronal membrane towards consciousness. For examples, membrane with many ion channels especially calcium ion channel, ion channels responsible for action potential in its axon, dipole march in its dendrites, synaptic potential in synapses, neuronal membrane making tripartite synapses with astrocyte, making the membrane perhaps a hub of both digital and non-digital information!

The reason for neuron-philia of consciousness is obviously the 'serenity' of neuronal genes in many senses. For example, there is severe downregulation of DNA-replication machinery, there are long repetitive sequences of DNA, and there are unusually lengthy non-coding DNA sequences, all of which lead to its proneness to mutation while there is subtle changes in informational environment (vibration in DNA, wave-genomics, DNA-phantom effect [8], DNA-Neutrino interaction). In addition, as a consequence of this negligible replication activity of neuronal DNA, the cytoskeleton of neuron remains unusually stable which is responsible for informational integration of all important organelles inside the neuron. Robust stability of its microtubular systems make neuron an optimal candidate for manifestation of consciousness utilizing various information-states.

At the molecular level of any cell, and especially in the present context of neuron, the process of enzymatic noncovalent synthesis (ENS) integrates enzymatic reaction at the ground with conformational changes occurring at the supramolecular level to generate higher order molecules [9], exemplified by generation of tertiary, quaternary and spherical structures of proteins. Similarly, at the level of the brain as a whole, neural signaling on the ground is integrated by means of supracortical awareness with higher order information geometry, symmetry and architecture in concurrence with the different designs at the fabrics of the universe, which are behaviorally expressed as different Worldviews! As there is no possibility of supramolecular chemistry without enzymatic reaction and covalent chemistry at the bottom, similarly manifestation of inexhaustible supracortical consciousness gets limited by the ability of the cerebral cortical neurons. Both situations are natural manifestation of tendencies in matter written in the fabric of the universe. This tendency is behaviorally expressed as consciousness-philia in neurons and neuron-philia in consciousness.

SCC is, therefore, a biological and especially a general neurological phenomenon and is not prerogative of any special being having any privileged brain. However, the effect of SCC in behavior becomes more pronounced in individuals who are ideologically more inclined towards its existence. Note the word 'idea'. Idea's location is always at cortico-supracortical event horizon. The same is also true for wisdom, which could be located at the boundary of the System.

J Andrew Ross, a freelance consciousness-researcher, defines supracortical consciousness in his own terms. "Supracortical consciousness may be described to a first approximation as a unified state of phenomenal reality that quangles with the omnium from moment to moment and thus enables us to regard ourselves as living in a superficially classical physical world." He relates SCC with Roger Penrose's position. "It seems to me that the Emperor's new mind, regarded as the subjective entity that reflects or complements reality as a whole, at least as we currently understand it, deserves to instantiate its own named variant of consciousness. I would like to suggest that we call this variant supracortical consciousness, to exapt a term I first met in the works of A. K. Mukhopadhyay, an Indian professor of Medicine who is also an accomplished mystic philosopher."

Apparently, if one wishes to demystify consciousness in neuroscience one needs to begin with SCC, which means initially becoming aware of existence of brain-independent consciousness by one's self-consciousness. When does so happen? When do we become aware of supracortical consciousness? Bottom up, during economic downturn within the brain and the cells are looking up for cosmic connection! Top down, during happening of intuition, illumination and revelation! What we experience as *Ananda* is said to be the result of SCC getting biologized at the level of neurological pleasure triangle constituted by three limbic nuclei (two amygdaloid nuclei in two hemispheres and septal nuclei in the midline) [10]!

During every experience, brain-consciousness communicates with supracortical consciousness for 'normalization' of its information states, resulting in visible energy-dark energy homeostasis through zero-point-energy (ZPE) state. From materialistic point of view, this has been described as entropy-stabilizing property of the brain. During sensation, perception and superficial conceptualization, such communication is not essential. The information states and homeostasis of visible energy-dark energy are managed within the systems. However, during deep conceptualization, during experiencing, during hypothesis generation, theorization and birth of a Worldview, this communication is inescapable, and has been always a happening.

During sleep and resting phase of the brain, communication between cerebral cortex and supracortical nature continues. In the phase of REM sleep there could be information loss from the brain [11]. During deep sleep there is possibility of gain of new information! The purging and acquisition route is cortico-supracortical and supracortico-cortical respectively. This is a normal physiological phenomenon, experimentally verifiable, and no one should search for supernatural in this communication.

The theory of SCC has an identical twin. This is the theory of multiple universe(s) forming the largest intellectually comprehensible systems, the Multiversity. Both theories convey an identical Worldview. The former is applicable in the human nervous system. The latter is in the context of the systems universe. Since consciousness is scale invariant, 'far beyond' at the level of astrophysics, here, also means 'deep within' in the context of the brain! That is the message supracortical consciousness conveys for the humanity. Consciousness is One but plurality in its behavioural expression has been introduced by imposition of the brain is another message to science. That intuitive perception is a reality, although rare, it happens, is the third message supracortical awareness offers to the neurologists.

Experience of supracortical consciousness is not an end in itself. Its experience is a new beginning. It is often asked, what unique characteristic makes us human, and completely different from any other living animal or entity? The answer is human being's ability of becoming aware of the existence of SCC! The ability to experience SCC makes us "human"! The present cortical being can rejuvenate himself, rediscover himself, redefine himself and reinvent himself! An impossible without awareness of SCC! In fact, human being has a better brain since the being is aware of his association and access to supracortical consciousness. We find hope that with persistence of this awareness, present cortical being holds the chance of evolving towards cortico-supracortical being, supracortical being, supracortical Godhead and supracortical autonomy across three centuries (nine generations) of cognitive evolution. In the upstream, supracortical consciousness bridges consciousness and cognition and in the downstream cognition and behavior are bridged.

COGNITION

Cognition is the act of knowing. George Miller, founder of the field of Cognitive Psychology, coined the name "cognitive neuroscience" in 1977. Michael Gazzaniga is considered the godfather of cognitive neuroscience.

Difference between perception and cognition

It is imperative to distinguish cognition from perception at this stage. Sensory perception in animal and human brain requires infrastructure of the nervous system; the sense end organs, their nerve tracts through thalamus leading to neurons in cerebral cortex that connects through yet non-observable layers with the cognitive apparatus. Cognitive apparatus, although, could work independent of the brain, requires such material infrastructure for manifestation as behavior. When the brain is there, the brain is used for behavioral expression of the effect of cognition.

Perception is a process of receiving and analyzing the external world by both sensory apparatus and cognitive apparatus of the systems distinguishing signal from the noise. If perception goes wrong, everything what follows would go wrong, namely formation of concept, development of knowledge symmetry, invariant design of the experience etc. and all would be distant from Wisdom / Worldview / OR (Objective Reality, the Reality that exits independent of anyone's observation). Difference of perception makes the world different for us. Differences crop up because of perceiving noise or a near-signal as the signal. Several interpretations of Quantum Mechanics exist and are different from each other because of difference in perception of eminent quantum physicists. Concepts in different religions are different and there is more difference in their interpretations because of difference in perception of their founders and so of its commentators. Cognition on the other hand, "…..refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered and used" (Ulric Neisser, quoted by Kandel) [12]. Cognition includes all processes from perception to action. In this sense cognition is a far broad umbrella to accommodate the spectrum from perception to behavior. Coupling of perception and cognition through mind is shown in **Figure 5**.

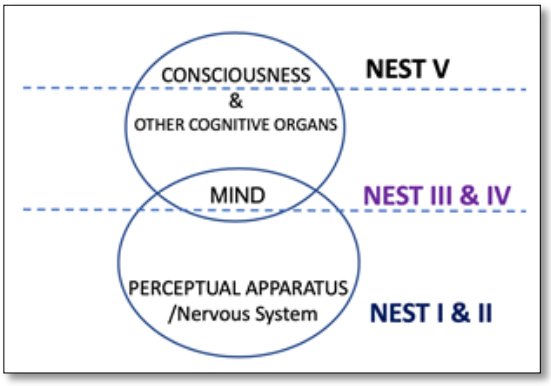

Figure 5. The Cognitive organ and the Perceptual apparatus (with or without nervous system) are coupled through Mind. Sensory apparatus and the nervous system are in nest I and II of nature. Mind and other cognitive faculty are placed in nest III and IV.

Consciousness operates from nest V of the nature-consciousness matrix.

The differences between perception and cognition have been shown in **Table 1.**

Table 1. Differences between perception and cognition.

Attributes	Perception	Cognition
Location in the Spectrum	Perception is at the downstream of the ladder, and announces the transition of Neurology to Psychology	Cognition is at the upstream of the ladder and ushers the transition of Psychology to Neurology and vice versa
Essential Apparatus / Organ	Sensory apparatus is the major organ for perception in animals with brain; sensory nerve endings, nerve tracts, thalamus and cerebral cortex.	Cognitive faculty forms the major organ for cognition; Mind, Self, Life and Consciousness. The Cognitive faculty are nonlocal and are independent of the brain
Whether Observable/Non-observable?	Most of the perception process happens in observable plane	Most of the cognitive process happens in non-observable plane
Interrelation	Perception makes cognitive process sensible	Cognitive process builds up concept out of percept, knowledge out of concepts, experience out of knowledge, and wisdom out of experience
Currency involved in the process	Currency involved in Perception are Signal and Digital Information	Currency of Cognition are intention and will supported by non-digital states of Information

Role of Subconscious in Perception and Cognition

Both perception and cognition have a major subconscious processing. In documentation of this subconscious processing in neuroscience there are contributions of three [12] legendary persons namely Helmholtz (implicit learning, memory and skill), Sigmund Freud (dynamic unconscious, dealing with conflicts, repressed thoughts, aggression and urges) and Benjamin Libet (elucidating role of pre-conscious in organization and planning for immediate action). These subconscious activities are huge in terms of size capacity might and efficiency, which mostly work in parallel and in present mode, and are reflected in electroencephalography (EEG) as Delta wave (0-4 hz/sec) and Theta wave (5-8 hz/sec).

Nature's domain, involved Process, and Authorities of Cognition

Nest III and IV of nature are the domain of cognition. This is a domain of true non-locality, although our description in nested hierarchy is for simplifying the understanding the complexity of the issue. In this domain, there is fusion of ontology with epistemology, phenomenology with axiology. Energy, Force and Field are not the currency there. The currency for operations of autonomous entities are 'will' and 'intention'. Therefore, there is no specified algorithm, no mathematical equation but the outcome is an integral relationship.

Involved in the process of cognition are faculty of cognition, their operations, and the currency that runs cognitive operations. There are recognizable milestones

in the process to constitute the ladder of cognition. There are layers to build up a canvas of cognition. The non-observable stratified layers which extend vertically between neural signal and consciousness are related to the process of cognition.

Faculty of Cognition

What sense organ could perceive are 'form' and movement. It is done through involvement of a cognitive faculty, called mind. Humanoid, operated by artificial intelligence, can perceive form and movement as well because of externalization of some of the faculties of mind in the humanoid. Planck's constants indicate cognitive limits of human mind for the perception of material world! Color perception, on the other hand, requires involvement of another, perhaps far higher cognitive faculty, the "life". No humanoid so far has been seen to perceive color. In dementia and depression, there is generalized decrease of color perception [13-15] by the patients. Perception of any "substance" (e.g., that the object is an apple, a piece of matter or an organ brain) is more difficult and is not possible by cognitive faculty such as mind and life. This requires involvement of an unique cognitive faculty, the "self". It is unique in the sense that it is categorically identical with consciousness and acts as chief executive officer (CEO) of the systems on behalf of consciousness. Consciousness itself as cognitive faculty perceives overall "Attitude" of the object, which is a resultant expression of conscience, values, ethics and aesthetics in the cognized object.

Sentient self is everywhere, in biology, physics and universe [16]. The basis of functioning of immune system is on the distinction between self and other-than-self. Popper and Eccles thought that the brain belongs to Self [17]. Specification of self for cognition as a non-fictitious entity has been recently reported in Trends in Cognitive Sciences [18]. Antonio Damasio's works on self [19, 20] in this context are of much relevance. The self as conscious agent remains as single one even when the perception splits, as explained in the recent revisit of split-brain phenomenon [21]. Any specific site for this self-inside the brain, although, is difficult to cite, the recent work [22] points out its positioning around right anterior genu of corpus callosum, obviously in certain state of mind/consciousness.

Therefore, we identify four cognitive faculty, namely mind, self, life and consciousness. Consciousness, life and self have no direct access to material world and are connected with the perceptual apparatus in the downward cascade through the common pathway of mind. As a faculty of knowing, mind cognizes information. The 'self' cognizes phenomenon and phenomenal information. "Life" cognizes disturbance in homeostasis of asymmetry-symmetry, uncertainty-certainty and dark energy-visible energy. Consciousness from deep inside the 'systems psyche' cognizes wisdom and attitude, and during selection process, the attitude of submission and "surrender".

There are twenty three distinctions between consciousness and mind, five contrasting features between mind and self, five similarities and five differences between consciousness and life in subtler plane as life-principle. The interested readers are directed to author's website, the page on conceptual contribution [23].

Cognitive Operations

Simplified, cognitive operations are four cascading operations. So far, there is no known equipment, device or appliance which could convert signal into information except mind. We can call it Operation I. From information to building up knowledge is the operation II, executed by self. In this operation there is build-up of a symmetry. The architecture of knowledge is transformed into manifold of experience by another operation, Operation III, which is executed by life. Any experience is systems-bound. For the experience to become wisdom, which shows concurrence of several systems, the operation which is mandatory is the operation IV, which is executed by none other than consciousness. Further to say regarding all four operations, only consciousness has the governing power, and no other member of the psyche has it.

In other words, without presence of operation of mind there are only noise and signal, and no information! Without the presence of operation by self, there is no formatting of information into knowledge and so no knowledge architecture is available. Without the operation of life, there could be no generation of experience. Without operation of consciousness there is no possibility of sublimation of experiential knowledge into wisdom! There is no Governance in the systems psyche when consciousness becomes non-functional!

Besides signal processing, therefore, there are operation for thought processing, knowledge processing, experience processing and wisdom processing! The brain appears to be a safe place for freedom of processing of thought, knowledge, experience and wisdom! Signal processing has been mechanized in automated AI system, and in molecular robots within cell systems, which have achieved a reasonable degree of perfection. Thought/Information processing is a property of mind (operation I), knowledge processing of self (operation II), experience processing of life (operation III), and wisdom processing of consciousness (operation IV). All four operations are possible only in a living system. In the living system

there are errors, mistakes and blunders while in automated signal processing system one finds only random and systematic error **(see, Table at the Appendix**).

Currency of Cognition

Will and intention, the currency of Cognition, operate with the support of various information-states. Information is that which impregnates mind to deliver 'form' (space and time) and energy (information-sourced invisible energy). Information is the father, mind the mother and space time and energy are three children! Mind itself is sterile. Mind owes its fertility to consciousness and fecundity to its attachment to material substance. Consciousness is expressionless without mind. The whole psyche is deaf and dumb without information!

Information is that which carries the intent of consciousness as contents in the mind to quench measurable uncertainty experienced within material nature which obeys the principles of quantum and classical mechanics. In this sense, information entangles matter with mind, self and life.

Source of any new information is "life". A system without "life" cannot create any new information.

The whole process of cognition is intertwined with corresponding information states [24]. Signals are space time construct of information. There is no meaning inherent in any signal. When a consistency in its meaning (thought) is observed, the state could be described as non-digital information, which is like a trifoliate leaf with a measurable folium, a content folium and an intent folium. The petiole of the trifoliate leaf draws nourishment from 'life'. This trifoliate information could be described as nondigital, non-quantizable semantic information **(Figure 6)**. But still this state of information is factorizable. The question which bothers the author, whether trifoliate geometry of such semantic information has anything to do with tripartite synapse in the cerebral cortex!

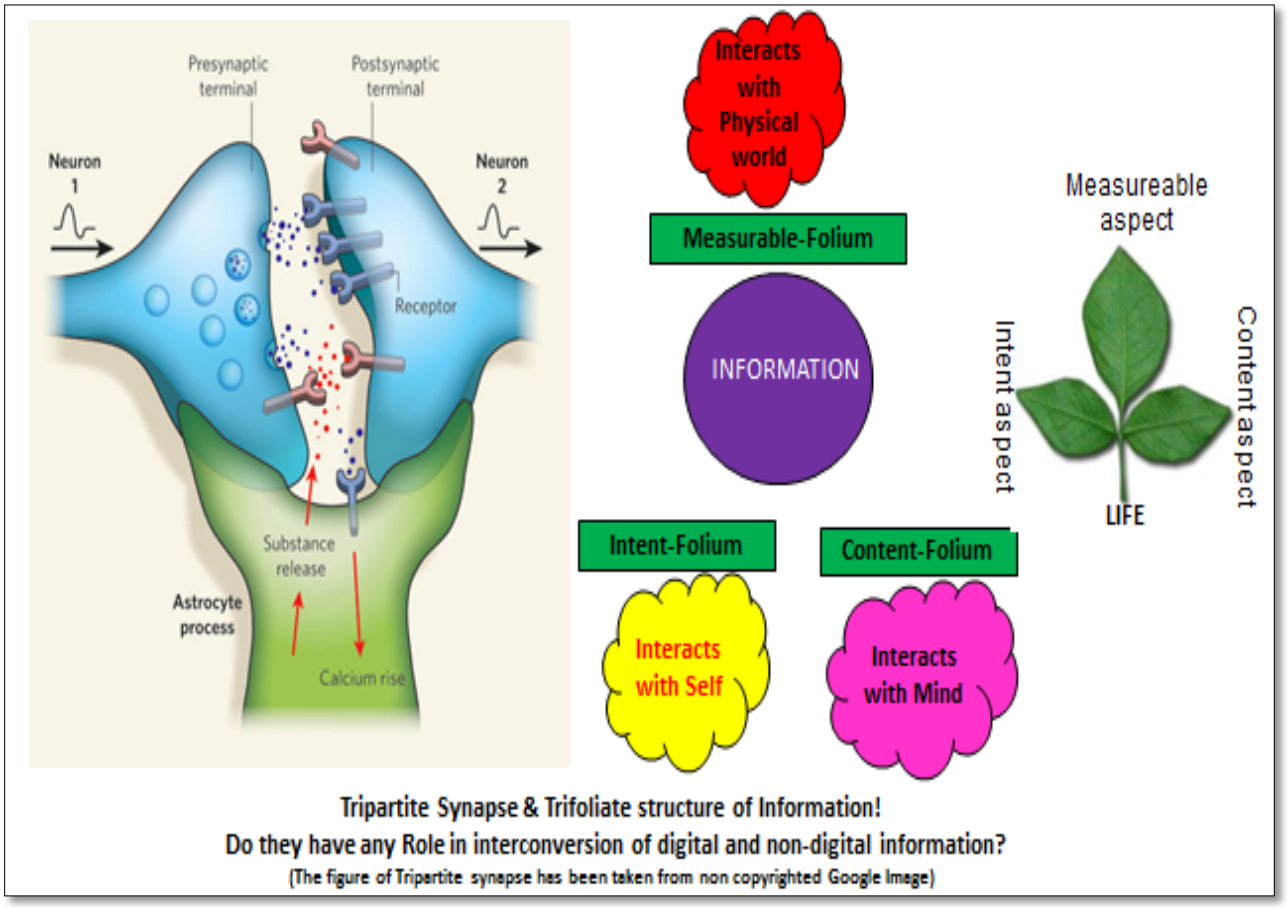

Figure 6. Tripartite synapse and Trifoliate structure of information! Do they have any role in interconversion of digital and non-digital information?

There is a state of information when it is non-reducible, non-factorizable and develops an invariant symmetry and could be used as a whole with its content and intent without any need of further deliberation. This information state could be called Gödelian information, which is in popular language is labelled as knowledge, or at best formative knowledge. Since a sphere can accommodate in minimum volume maximum amount of contents, the geometry of Gödelian information is supposed to be spherical! The Gödelian information, therefore, is a state of information developed following a special art of package making. Information could be packaged in many different ways, and the stack of such packages make information manifolds. Our experiential states, if ever observed, would be observed as such information manifolds. However, all geometrical shapes containing substance could not be substantially reduced to a point. The notable exception is the sphere. All spheres could be reduced to a point. Multiple spheres can originate from one single point. When countless spheres of experience are reduced to a common point, we could describe this state of information as information crystal, which in popular language has been called the sublime knowledge or the wisdom.

The Ladder of Cognition

The milestones in the non-observable layers between signal and consciousness along the ladder of cognition [25] are Signal, Information, Knowledge, Experience and Wisdom. In the terms of "knowledge", these are respectively Data-based factual knowledge, Informative knowledge, Formative knowledge, transformative knowledge and sublime knowledge.

The Cognitive Canvas

There are ten layers in the canvas of cognition [26]. Any canvas consists of embroidery on the surface, fabrics in the middle, and ground material at the base. In the cognitive canvas, the embroidery consists of two layers; superficial layer of macro-events and behind layer of micro-events. The fabric consists of three layers; (i) of mind, information and memory, (ii) of intelligence and emotion and (iii) of operators such as self and life. The base is constituted by five vertically disposed sectors of consciousness described as supporting consciousness, participating consciousness, intervening consciousness, creative consciousness and consciousness as unfathomable ground. The caterpillar model of consciousness has been described [26]. Supporting consciousness supports autonomous operations of mind, self, life and information and brings coherence in those autonomous activities. The systems remain awake! Following development of coherence, participating consciousness makes 'self' aware of the contents of consciousness while the autonomous operations maintain an order. On the basis of experience, consciousness can negotiate and predict events, and dynamically intervenes to censure harmful ones for maintaining the integrity of the systems. Creative consciousness is engaged in research and development of design to have the best possible option. Thus, it offers choice beyond algorithmic pre-specifications. At the bottom of the base, the ground consciousness is stacked with wisdom, information crystal arranged in manifold. Decision/will/volition of consciousness springs from this deepest layer of the base of the canvas.

The Layers between Neural signal and Consciousness

The layers between neural signal and consciousness have been described in my earlier papers [26,3]. Layers are as follows; Sublayer-1 of patterns of complex signal, sublayer-2 of neuro-informational geometry, sublayer-3 of different architectures of ensembled neuro-information, sublayer-4 of underlying design in information manifold, and the final layer, layer-5, is of consciousness **(Figure 7 and Table 2)**.

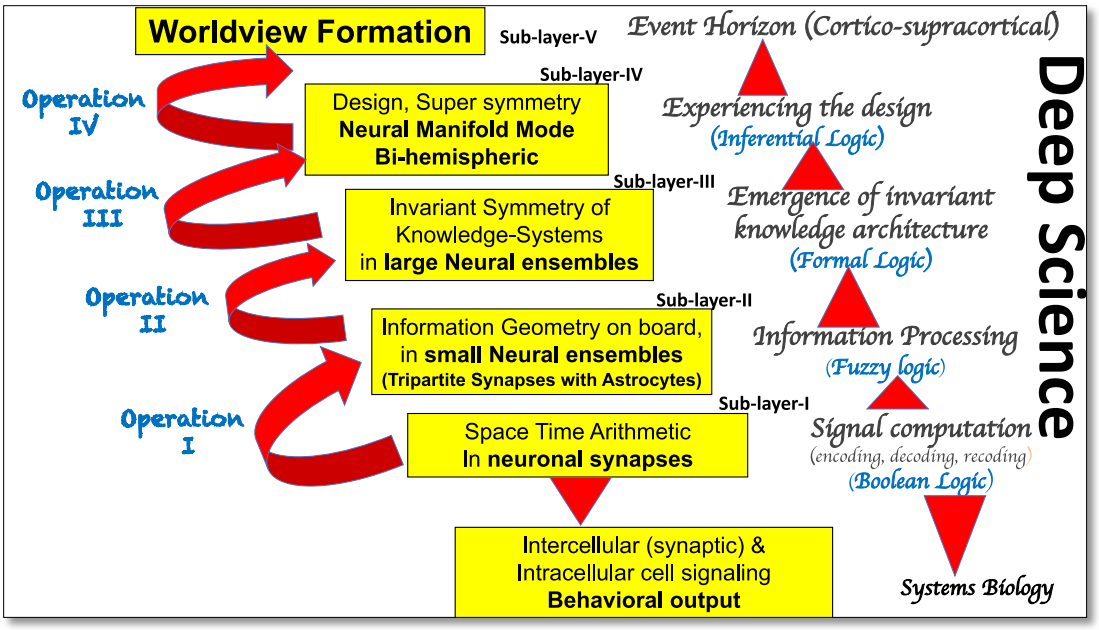

Figure 7. Shows five sub-layers leading from neural signal to consciousness by four cascading operations shown on the left side, corresponding neural ensembles at the centre, and the concomitant processing layers on the right side of the figure. The figure tentatively defines the steps for Deep Science.

Table 2. The layers between neural signal and consciousness.

Sub-layers	Neuro-cognitive ladder	Supporting neural ensembles/connectomes	Logic of processing	Behavioral outcome
Sub-layer 5	Governing Consciousness	Whole brain embedded in the Multiverse. Vertical, Horizontal, Global neural ensembles. Multi-versal brain at Peace. Stable fluctuations	Intuitive Logic	Worldview formation. Manifestation of Governing Power
Sub-layer 4	Emerging Design in Neuroinformation-Architecture	System-confined, Near-perfection. Fluctuating Invariants of the whole brain connectomes. Vertical and Horizontal harmony of connectomes.	Inferential Logic	Theorization. Paradigm developing. Manifestation of Censuring Power
Sub-layer 3	Symmetry of Neuroinformation-Architecture	Because of involvement of Subcortical midline structures (SCMS) the whole brain connectomes are in fluctuation with a tendency for becoming Invariant, not compromising with regional stability	Formal Logic	Hypothesis Generation. Manifestation as Sensor
Sub-layer 2	Neuroinformation-Geometry. Tripartite neuron-astrocyte synapses are roped in	Somatosensory vertical and horizontal cortical neural ensembles. Tripartite neuron-astrocyte synapses are roped in. Usually mono-hemispheric.	Fuzzy Logic	Concept formation
Sub-layer 1	Neuro signal complex Patterns	Somatosensory vertical neural ensembles. Mono-hemispheric	Boolean Logic	Perception

As stated, the governing power is vested with only sublayer-5. Its accord (in behavioural science called, 'will') is essential to uphold the subconscious processing at sub-layers-1, 2, 3 at conscious level. Following intervention by consciousness for this accord, sensation becomes perception (operation I), perception proceeds (operation II) for concept formation, concepts generate (operation III) hypothesis, and finally several hypotheses of a paradigm is transformed (operation IV) into a Worldview.

Organizing Power of the Cognitive Faculty

In the cognitive apparatus, consciousness is the chief organizing officer. Since organization requires manipulation of space and time this entails mind, the event-making entity to get engaged in the process. However, mind, left alone is sterile. Mind's virile power comes from consciousness. Mind remains the final common path for organisation. The chief gets it done through organizing power of self and organizing power of life. None of the chief, life, and self has direct access to physical world where organisation will be observed. All three work through mind in this organisation. The differences between organization by Self and organization by Life are shown in **Figure 8**.

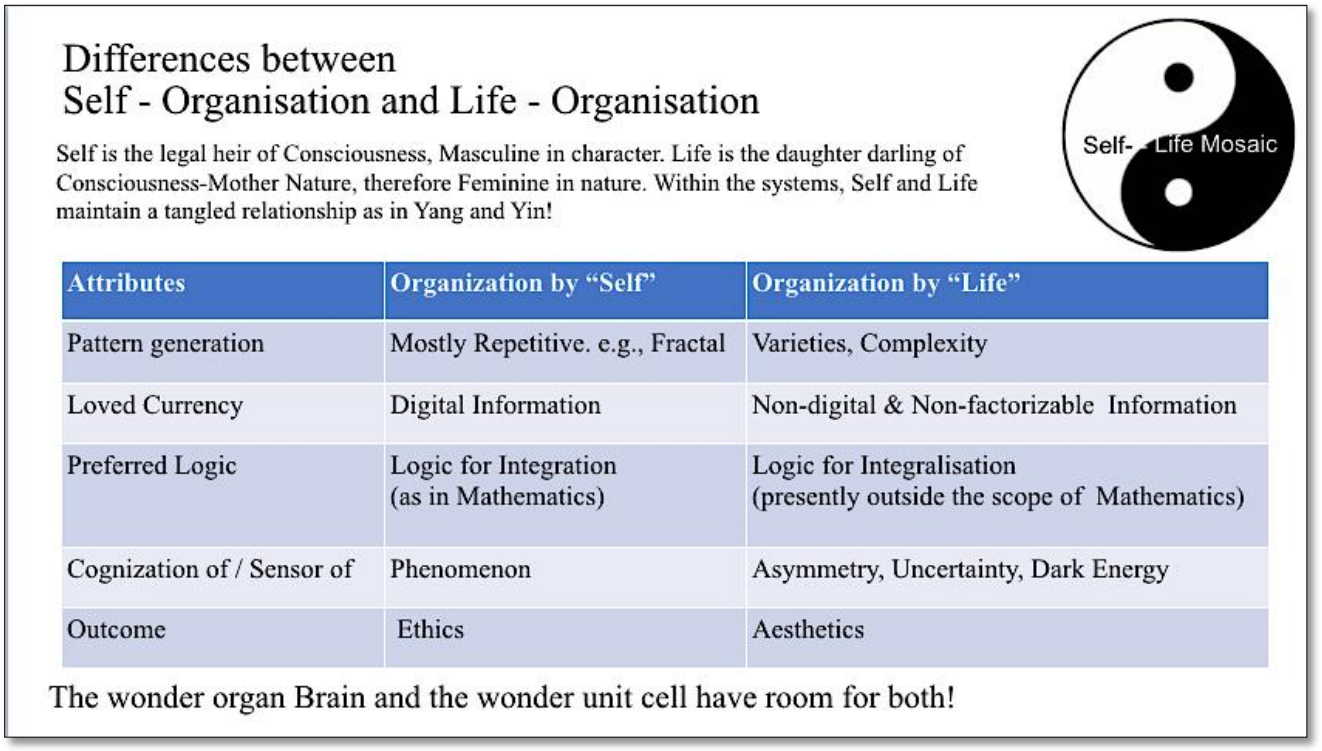

Figure 8. Differences between self-organization and life-organization.

To note, self-organization cannot offer the systems the ability to rediscover itself. Life-organization does. Organization by consciousness offers re-inventing and re-defining ability to the systems.

Downward causation by orchestrated descent of the Objective Reality, OR, (the Reality independent of anyone's observation), that of supracortical consciousness (SCC) is coordinated with vibration (space time domain of signal frequency) of molecules such as DNA, histone and protein. Vibration is transmitted down in the intraneuronal supramolecular chemistry of folded protein so that protein with tertiary structure supports knowledge (knowledgeable protein), protein with quaternary structure supports experience (experienced protein) and protein with spherical structure, e.g., histone, supports wisdom (wisdom protein) [25]. Driver of nuclear DNA organization is said to be histone [27,28]! Supramolecular organizing centers (SMOCs) have been recognized inside the cell as signalosome, as signaling machine in innate immune activity [29,30]. The author considers signalosome to be the junction of automated signalling and autonomous operations, also the original site of initiation of malignant transformation in a cell. If sensing is considered a very rudimentary form of cognition, then many kinds of sensor used in robotic industry could also be said to have cognitive properties. Molecules working within protoplasm have been reported to have sensor as well as censuring property. These are examples of molecular cognition affecting cellular behavior [31-34].

BEHAVIOR

When you are asked to look into a matter, you are asked not only to observe but also to see. You observe the outward character and you see the inner nature! Character is what is expressed. Nature is what is within. Acts of consciousness and cognition are happening in non-observable plane. Behavior happens in observable domain. Individual consciousness and cognition are within the nature of the being. behavior is what is expressed in his/her character. Within and without, nature and character fall therefore within the ambit of consciousness cognition and behavior. Behavior is the expressed outcome of the process of cognition by a conscious entity irrespective of presence or absence of the organ brain.

Complex decision-making is one of the toughest behavioral expressions. This has been observed in acellular slime-mould, in unicellular ciliate, Physarum polycephalum, which are brainless but behave as multiheaded [35-38]! The scientists, who by computer simulation have started mapping the apparently non-observable (dark) cosmic matter web that connects the galaxies, are surprised to discover that the design they obtained has a remarkable similarity with the lacy design produced by this brainless multiheaded mould [39]. This is a kind of hard evidence of interconnectedness of matter-science, cognitive science, behavioral science and science of design in one hand and, consciousness, astrophysics and cosmology, and biology on the other. Bacteria, which are more complex than such unicellular ciliates, are also small but not stupid! They exhibit quorum-sensing [40]. Plants suffer from stress and canopy light quality modulates stress responses in plants [41]. Sungchul Ji proposes wave as symmetry principle underlying the language of cosmos (cosmese), cell (cellese) and human being (humanese) [42].

For those entities which or who all have brain, the neural infrastructure of the brain shapes behavioral expression. And in the long run, behavior uses the property of neuroplasticity to shape the brain. However, "most neuroscience today places a premium on extremely detailed recordings of the smaller components of nervous systems, such as tagging proteins on cell membranes to better photograph single neurons, or building tiny assemblies of metal pins to measure the electrical activity in a region of the brain. Unfortunately……much less value has been placed on the rigorous and detailed study of behavior. Why is there so little interest in nurturing the study of behavior, and such intense interest in detailing the nervous system?", the question is raised in the paper, "Neuroscience Needs Behavior: Correcting a Reductionist Bias" [43]. Further, as we are all aware that without "life", manifestation of consciousness in behaviour stops. How does the life-processes bridges consciousness and behaviour? It can be said simply, by acting as a cognitive faculty that is essential for homeostasis of cognitive apparatus; homeostasis of uncertainty-certainty while achieving the graded hierarchy of goals, homeostasis of asymmetry-symmetry by symmetry braking and symmetry making and homeostasis of dark energy-visible energy across the zero-point energy state of the infrastructure such as brain! At near zero-point energy state brain-bound consciousness communicates with the brain-independent consciousness at ease!

Behavior could be studied as a) reflex behavior, b) non-automated behavior c) decision-making ability, d) communication/language skill, and e) analyzing overall attitude.

Reflex behavior

Some behavioral expressions have been automated through monosynaptic or poly synaptic reflex pathways spanning over one or multiple segments of the neuraxis even often involving cerebral cortex or subcortical striatum. This is to a large extent true that automated behavior of the being which is expressed as overall personality is mostly automated and routed through the striatal extrapyramidal motor nuclei. Automation is conferred to those components in an autonomous system, which have achieved a reasonable degree of perfection.

Non-automated behavior

The finer cognitive behavior like awareness, choice and making decision are not left with such automation in an autonomous individual having autonomous cognitive faculty such as mind, self, life and consciousness. In the nervous system, pyramidal system gets involved in neural expression of such behavior.

Decision-making process

Decision making process is multi-layered, hierarchically structured and often follows a labyrinthine course. It is neither fully democratic nor completely autocratic, and never automatic. In holistic decision, all consciousness, mind, self and life concur with each other in quality management of information. We are to develop criteria for psychology and psychiatry practice which can distinguish a decision from mind, decision of a confident self, decision by 'life' and decision coming straight from consciousness and decision of the cognitive organ as a whole.

Communication/Language skill

Verbal or written language is one kind of behavioral expressions, expressing the substance inside as 'form',

by an art or operation which delivers a specific space time relationship, the form which is in*form*ation's inside! Gesticulation and body language is another kind of behavioral expression. Communication changes the surrounding environment. Both pyramidal and extrapyramidal systems of the nervous system contribute in spoken, written and body language. We are yet to develop criteria in the practice of psychology and psychiatry by which we would be able to distinguish whether the subject has been speaking/behaving from his mind (mostly in thoughtful state), from self (mostly in confident state), from life (mostly sharing his experience) and from consciousness (while expressing one's decision, will)! Criteria are to be developed to distinguish an informed communication from intuitive communication, illumined communication and revealed communication.

Overall Attitude

As said, attitude is what emanates from the system out of the values it upholds (by Mind) on the prescribed rules (as observable by Senses) of the system, with aesthetics (supported by Life) and ethics (supported by Self), all united at the top by Conscience. Conscience represents the top-boss in axiology of consciousness and its activity depends on the degree of incorruptibility of the conscious states. Therefore, behavior alters with alteration of mind, self, life and states of consciousness. But how? We need several case studies to document the hypothesis!

Role of Cerebellum in Behaviour

"In cognition the cerebellum gets no respect. Located inconveniently on the underside of the brain and initially thought to be limited to controlling movement, the cerebellum has long been treated like an afterthought by researchers studying higher brain functions." "The biggest surprise to me was the discovery that 80 percent of the cerebellum is devoted to the smart stuff." "Everyone thought the cerebellum was about movement. Our research strongly suggests that just as the cerebellum serves as a quality check on movement, it also checks your thoughts as well -- smoothing them out, correcting them, perfecting things", - Nico Dosenbach, the lead author of the paper published in the journal Neuron [44]. Cerebellar neurons are very sensitive to alcohol. Therefore, in drunken state individual's behaviour not only expresses imbalance of posture but also poor-quality control of thoughts and speech. Further, of all the parts of the brain, cerebellum has the largest number of astrocytes, much more than the cerebral cortex, which has been traditionally accepted as the 'thinking' brain! Astrocytic synapses with neurons perhaps have something to do with inter-conversion of digital and non-digital information. We are reminded of trifoliate structure of information and tripartite neuro-astrocytic synapse again **(Figure 6)**!

THE BRAIN AND HEART AS SENSOR OF BEHAVIOR!

Emergence of Leadership Quality

Every individual free biological cell is a sensor of the environment in depth; vacuum, sub-vacuum and consciousness. Therefore, cellular memory, like vacuum memory, is holographic in nature and cell's response to any stimulus is always holistic! Biological cell itself is an entropy-stabilizing unit by its property of uncertainty-certainty homeostasis, asymmetry-symmetry homeostasis and dark energy-visible energy homeostasis. This ability is compromised when a number of cells come together to make any tissue and organ. Two exceptions exist; the brain and the heart. These two organs have shown enhanced ability of sensing deeper environment, vacuum, sub-vacuum and consciousness, probably because of a combinatorial effect of their members, as 'networked' in the brain, and syncytium formation in the heart! Interestingly no other large organ in the body except heart and brain, has both vertical and horizontal disposition of specific functions! Left heart right heart with atria above and ventricles below; left hemisphere and right hemisphere with brain stem limbic system and cortex, one on other! Also, there is a fusion of verticality of the principal operations of cognition and behavior and horizontality of physical unity in these two organs. Horizontality in disposition is for consolidation of the sensed perception for behavioral expression. The leadership quality emerges on the basis of this vertical depth-sensing activity of the brain and the heart and consolidation of the perceived sense horizontally for behavioral expression. There is another organ, tubular in nature, cells are not networked or form syncytium but physiologically function distribution occurs on segmental basis. We are talking of Gut! Like heart, gut has its rich nerve network too. We are familiar with a popular phrase of gut feelings (?sensing non-digital information). Leadership depends on this organ also!

Unlike the brain, which works as a networked organ of its 10^{11} constituent neurons, the heart is a syncytium of millions of cardiac myocytes! That is the reason why the heart could perform as a better sensor of vacuum, sub-vacuum and consciousness than the brain! That could also be the reason why the heart could sense non-digital information better than the brain **(Figure 9)**! That might also be the reason why the heart's memory is more holographic than that of brain! There are special neuro-cardiac myocyte junctions where neurotransmission occurs in a 'quasi- synaptic' way [45]. These cardiac synapses, like synapses in cerebral cortex show plasticity which is important for learning

and memory [46]. Because of robust brain-heart communications [47-50], there remains a possibility that some memories formed in the brain, especially episodic memory, existential memory and memory of intuitive perception are passed on to and stored in the heart [51-53].

Heart's access to deeper recess of nature; vacuum sub-vacuum and Consciousness	Brain's access to deeper recess of nature; vacuum sub-vacuum and Consciousness
Heart is a cellular syncytium of millions of cardiac myocytes. Therefore, access is mightier in spite of less wt. Wt: 250-350 gm.	Brain is a networked organ of 10^{11} neurons and 2-10 times of glial cells. Therefore, access is comparatively constrained. Wt: 1300-1400 gm.
More access to non-digital and non-factorizable information rather than digital information	More access to digital information rather than non-digital and non-factorizable information
Because of comparatively more access to depth, entropy stabilizing capacity is comparatively more	Because of comparatively less access to depth, entropy stabilizing capacity is comparatively less
Memory storage and retrieval are largely holographic	Memory storage and retrieval are less holographic
Behavioral expression is mostly non-verbal, rich in feelings and emotion	Behavioral expression is more verbal, rational and logical

Leading by Heart (substance) and Leading by Head (mass) are brought to balance when one leads with Guts

Figure 9. Differences between heart and brain in accessing to deeper recess of nature.

We are to distinguish in behaviour of a person whether he has been leading from the heart or the head, managing with mesoderm or managing with ectoderm and how the weight (1300-1400 g) of the brain and the substance of the heart (weighing 250-350 g) are balanced when the leader leads with guts (endodermal management)! Successful leaders exhibit three-derm embryonic leadership, leading simultaneously from the head, heart and guts! "Gut-brain" probably balances the inequality of weight and substance of the "heart-brain" and "head-brain"! As put by Silvia Damiano, Founder and CEO of My Brain Institute and Bahar Rassouli, Director, People Performance, in such three-brain leadership the leader encourages everyone to embrace their own leadership! In fact, the leadership becomes upside down! This kind of leadership is characteristic of a person in whom the brain really behaves as an inverted tree! Such leaders, author believes, have full access to supracortical consciousness!

Coming back to the brain! What does the brain senses as a sensor? According to author, the brain senses "attitude" in others, attitude in the surrounding neighborhood and environment! When does the brain gain such efficacy? This efficacy is more when the brain can operate really as one whole! The brain usually functions as fragmented groups of ensembles of neurons. Occasionally, the brain operates as a whole, for example while experiencing, while taking a conscious decision. For quality output during such functions there is requirement of four levels of integrations within the brain; classical integration, quantum integration, pre-quantum integration and pre-prequantum integration The last one is to become conducive of Mother Nature-Consciousness. By Mother Nature it is meant the nascent nature, from which the whole of nature has germinated, which also could be stated as kinetic pole, mobile facet or executive front of consciousness.

Evidence are emerging supporting the idea that brain can work as sensor from the research on "internets of brain" [54,55], although limited presently to signal communication between brains [56]. The experiment proves that a cohort of several brains could be smarter in efficiency than a single brain. The question arises which one is better, to become smarter or to become aware? The answer might be to become smart for greater awareness! Alan Aspect's experiment on nonlocality [57], reinforcement of this experiment by Nicolas Gisin [58], EPR Paradox described in brain's behaviour [59] and the latest experiment on nonlocality

in 2002 [60] could throw light of inter-netting of brains connecting various information states in deeper sub-quantum nests. Human brain is therefore, not a 'stand-alone' information processor! Our brains are interconnected at different depths of nature! Human brain could also be grown in the laboratory. Could this brain be sentient? Does the future of human being belong to ethically sourced brains [61] or to "an artificial brain from a time crystal" [62]? In absence of inputs from sensory apparatus, does laboratory grown cellular brain communicate supracortically through signal and other information states? Are we in a position to define "life" as fracto-resonant [63] entity from lifeless fractal brain? The answer would come from Deep Science of prequantum vacuum, sub-subquantum void and consciousness. Till such time, "Like an ant in a wheat harvest we are happy as long as we carry a load bigger than ourselves"-Rumi.

The Nonlocal Psyche

All members of the systems psyche are nonlocal. Whenever one finds this extraordinary cohabitation of consciousness, mind, self, life and various information states, it is expected that there could be a formation of a psyche, the decision-making organ, irrespective of presence or absence of the organ brain. Therefore, the psyche itself is nonlocal but acts through a local system such as brain, which is conducive for it.

Also, there is interconnectedness of systems-localized psyche and its true nonlocal state in different depths of nature. The localized form happens because of "particulate" nature of self, which acts as CEO of the system on behalf of consciousness. It is well said that "Hidden in the utmost depths of the Cosmic Psyche is the fundamental law of the Universe" [64]. The big idea of supracortical consciousness and this nonlocal perspective of the systems psyche brings human species out of evolutionary cul-de-sac and ushers a new speciation with emergence of Homo spiritualis from the present Homo sapiens [65].

To go to the crux, how this exploratory approach could be pipelined for confirmatory research is to investigate the consciousness-matter relationship [66]. The easiest way to do this is in the acellular slime mould model [35-38]. The best way to study matter-consciousness relationship experimentally at the highest-order state is to study Neutrino-Brain interaction [67], which alters brain-consciousness, cognition and behavior in the subject-systems. There are a number of clinical cases available in psychology and psychiatry clinics to study this altered brain-neutrino interaction! This will be a new beginning for establishing the systems science of Consciousness. At the infrastructure level, the dendritic mat and the free non-synaptic spines on the apical dendrites of pyramidal neurons come into research focus here.

The *Brain* of a Brain

Evolution of human brain is still an ongoing process. In fact, cognitive evolution of human brain has been said to be at its highest. There are many examples of emergence of new forms of cognition such as theory of mind, recursive thinking, metacognition, appreciation of feed forward loop in behavior, vertical reasoning, the abstract language, integral relational logic with emergence of the ability to ask vertically straight, tough and pointed questions with "what" and "why" etc.

We require a new infrastructure to develop in the present brain to have proper access to SCC and its behavioral expression. At the beginning, this will develop and expand from the existing ones; the dendritic mat at the top layer of the cerebral cortex and the non-synaptic spines on the apical dendrites of the pyramidal neurons of the cortex. These dendritic spines provide cognitive resilience against Alzheimer's disease [68].

The existing infrastructure requires sharpening, consolidation and probably some new inputs since it is not possible to explain acquisition of many new ways of knowing and feeling without a new formation. In terms of its perceptual, receptual (ability to categorize) and conceptual ability, it is expected that this new emergence will be accompanied by formation of a new structure, a new brain, the *brain* of a brain [69]. This would be responsible for (i) integration of sensory, extrasensory and nonsensory perception (ii) integration of surface, elementary and depth phenomenology and (iii) integration of cognitive, psychomotor and affective brain. In response to this demand it is envisaged that three groups of cortical neurons would show activity in forming this new centre. (i) Cortical neurons which have already access and expertise in non-local communication through supracortical route, (ii) The mirror-neurons in cerebral cortex, which have already contributed a lot in the development and spread of culture but with cognitive closure look like intelligent dwarfs in individual capacity, although retaining the ability to long for a new access to sub-quantum domains of nature, and with (iii) a possible contribution from stem cells reserve of the 'brain marrow' [70]. In such new formation, we are not excluding the possibilities of several useful mutations in concerned neuronal DNAs during brain-vacuum interaction [67], however keeping our fingers crossed since till today all genetic mutations with loss or gain of functions or otherwise are known for disease, or transformation of cell in a malignant way and not found for any new speciation! Such brain in a new formative state is like an early universe when neutrinos run mighty and

determine galaxy formation (see brain-neutrino interaction hypothesis [67])!

CONCLUDING REMARKS AND PERSPECTIVES

Consciousness cognition and behavior operate on vertical timeline involving different depths of nature and corresponding information states. This is Deep Science, which in its enquiry works with ontological reversals at the level of information, life and consciousness; information is prior to space time and energy, life is prior to matter and consciousness is the source of power of the brain. Intelligence requires involvement of 'life', sentience and consciousness in addition to information signal and memory. Cognitive homeostasis is executed by 'life'. Governing power in cognitive activity is with consciousness. Its 'will' and intention are meant for quality management of information. Mind is the final pathway in psyche for its behavioral expression, for converting 'substance' into form. Infrastructure such as brain has added value in behavior. Comparing and contrasting the viewpoint expressed in this paper with as exist in present cognitive neuroscience, we may conclude like Rumi, "you've never really listened to what God has always tried to tell you, yet you keep hoping after your mock prayers salvation will arrive".

There are three fundamental questions as mentioned in *Prasna* Upanishad. What is God? Who am I? What is this world? These three questions are on intellectually incomprehensible Infinity! Consciousness, cognition and behavior respectively are variants of these three absolutes, which could be intellectually comprehensible absolutes for cognitive neuroscience. To find out their relationship, is the purpose of life of a cognitive scientist.

In this journey, "in order to find our way, we must become lost" (Bayo Akomolafe). We have a "Deep History of ourselves: The four-billion-year story of how we got conscious brains" [71]. In this journey we might have been lost many times and found our way again! At present we are on a trip to Deep Science how consciousness has shaped our brain and behavior! This paper is, therefore, an introduction to a wide scale research initiative for Deep Science of consciousness, cognitive neuroscience and the science of the matter! All three domains are interconnected by different information-states within a real-life situation. In the context of artificial intelligence whether it is blue brain project [72], neuromorphic computing [73], or neuroscience inspired AI [74], or marriage between neuroscience and AI [75], the science of information remains the central pivot to run the desired mill. Twenty first century is for developing the science of these information-states. Twenty second century is for unveiling the "life". Twenty third century is the century of near-completion of the purpose the scientists have been working for.

REFERENCES

1. LaViolette PA (2011) The cosmic ether: Introduction to subquantum kinetics. Physics Procedia 38: 326-349.
2. Klein A (2020) The reincarnation process: A scientific perspective (In Press)
3. Mukhopadhyay AK (2019) Communication of the "Objective Reality" as Signal to the Senses in Orchestrated Non-Reductive way. Arch Neurol & Neurosci 4.
4. Mukhopadhyay AK (2016) Systems psyche: Its structure, operation and possible molecular links. Psychol Behav Sci Int J 1: 555565.
5. Mukhopadhyay AK (1985) Frontiers of Research for Human Biologists. Conscious Publications, New Delhi, pp: 1-6.
6. Mukhopadhyay AK (2006) Supracortical Consciousness. An opening to multiple new doors of Science. The Enworlded Subjectivity. Its Three Worlds and Beyond. Project History of Indian Science, Philosophy and Culture (PHISPC). Center for Studies in Civilization, New Delhi, pp: 380-446.
7. Wilber K (2007) Integral Spirituality. Integral Books, Boston.
8. Gariaev PP (2011) Institute of Linguistics of Wave Genetics.
9. Shy AN, Kim BJ, Xu B (2019) Enzymatic noncovalent synthesis of supramolecular soft matter for biomedical applications. Matter 1: 1127-1147.
10. Mukhopadhyay AK (1987) Ananda-Biologizes supracortical consciousness at the level of limbic nuclei. The dynamic web of supracortical consciousness. Conscious Publications, New Delhi: 133-135.
11. Crick F, Mitchison G (1983) The function of dream sleep. Nature 304: 111-114.
12. Kandel ER (2013) Principles of Neural Science. The McGraw-Hill Companies Inc. USA, pp: 370-391.
13. Arnaoutoglou NA, Arnaoutoglou M, Nemtsas P, Costa V, Baloyannis SJ, et al. (2017) Colour perception differentiates Alzheimer's Disease (AD) from Vascular Dementia (VaD) patients. Int Psychogeriatr 29: 1355-1361.

14. Franklin A, Sowden PT, Burley R, Notman L, Alder E (2008) Colour perception in children with autism. J Autism and Dev Disord 38: 1837-1847.

15. Maserati MS, Mitolo M, Medici F, D'Onofrio R, Oppi F, et al. (2019) Color choice preference in cognitively impaired patients: A look inside Alzheimer's disease through the use of Luschercolor Diagnostic. Front Psychol.

16. Theise ND, Kafatos M (2013) Sentience everywhere: Complexity theory, Panpsychism & the role of sentience in self-organization of the universe. JCER 4: 378-390.

17. Popper KR, Eccles JC (1977) The self and its brain. Springer-Verlag, Berlin, Heidelberg, London, New York.

18. Christoff K, Cosmelli D, Legrand D, Thompson E (2011) Specifying the self for cognitive neuroscience. Trends Cogn Sci 15: 104-112.

19. Damasio A (2010) Self comes to mind: Constructing the conscious brain. Pantheon Books, New York.

20. Damasio A, Damasio H, Tranel D (2013) Persistence of feelings and sentience after bilateral damage of the insula. Cerebral Cortex 23: 833-846.

21. Pinto Y, de Haan EHF, Lamme VAF (2017) The split-brain phenomenon revisited: A single conscious agent with split perception. Trends Cogn Sci 21: 835-851.

22. Sturm VE, Sollberger M, Seeley WW, Rankin KP, Ascher EA, et al. (2013) Role of right pregenual anterior cingulate cortex in self-conscious emotional reactivity. Soc Cogn Affect Neurosci 8: 468-474.

23. Mukhopadhyay AK (2018) Conceptual Contribution. Available online at: https://akmukhopadhyayconsciousness.com/conceptual-contribution.php

24. Mukhopadhyay AK, Mukhopadhyay AS (2019) Visualizing Information as a dynamic entity roadmap of deep science, AI and humanity. Psychol Behav Sci Int J 13: 555867.

25. Mukhopadhyay AK (2017) The ladder of cognition: Abstract operations, molecular biology, systems science. Ann Psychiatry Ment Health 5: 1107.

26. Mukhopadhyay AK (2018) Cognitive canvas: Molecular embroidery, fabric and the base. EC Psychology and Psychiatry 7: 428-439.

27. Baumann K (2015) Chromatin. Drivers of nuclear organization. Nat Rev Mol Cell Biol 16: 67.

28. Therizols P, Illingworth RS, Courilleau C, Boyle S, Wood AJ, et al. (2014) Chromatin decondensation is sufficient to alter nuclear organization in embryonic stem cells. Science 346: 1238-1242.

29. Qi Q, Hao W (2015) Supramolecular Organizing Centers (SMOCs) as signalling machines in innate immune activation. Sci China Life Sci 58: 1067-1072.

30. Fitzgerald KA, Kagan JC (2020) Toll-like receptors and the control of immunity. Cell 180: 1044-1066.

31. Shi J, Zhao Y, Wang Y, Gao W, Ding J, et al. (2014) Inflammatory caspases are innate immune receptors for intracellular LPS. Nature 514: 187-192.

32. Broz P, Dixit VM (2016) Inflammasomes: Mechanism of assembly, regulation and signaling. Nat Rev Immunol 16: 407-420.

33. Levy M, Shapiro H, Thaiss CA, Elinav E (2017) NLRP6: A multifaceted innate immune sensor". Trends Immunol 38: 248-260.

34. Kim KK, Kim R, Kim SH (1998) Crystal structure of a small heat-shock protein. Nature 394: 595-599.

35. Beekman M, Latty T (2015) Brainless but multi-headed: Decision making by the acellular slime mould Physarumpolycephalum. J Mol Biol 427: 3734-3743.

36. Tang SKY, Marshall WF (2018) Cell learning. Curr Biol 28: R1180-R1184.

37. Dexter JP, Prabakaran S, Gunawardena J (2019) A complex hierarchy of avoidance behaviors in a single-cell eukaryote. Curr Biol 29: 4323-4329.e2.

38. Schenz D, Nishigami Y, Sato K, Nakagaki T (2019) Uni-cellular integration of complex spatial information in slime moulds and ciliates. Curr Opin Genet Dev 57: 78-83.

39. Burchett JN, Elek O, Tejos N, Prochaska JX, Tripp TM (2020) Revealing the dark threads of the cosmic web. Astrophys J Lett 2 891: L35.

40. Shapiro J (2007) Bacteria are small but not stupid: Cognition, natural genetic engineering and socio-bacteriology. Stud Hist Philos Biol Biomed Sci 38: 807-819.

41. Courbier S, Pierik R (2019) Canopy light quality modulates stress responses in plants. iScience 22: 441-452.

42. Ji S (2017) Waves as the symmetry principle underlying cosmic, cell and human language. Information 8: 1-25.

43. Krakauer JW, Ghazanfar AA, Gomez-Marin A, Maclver MA, Poeppel D (2017) Neuroscience needs behavior: Correcting a reductionist bias. Neuron 93: 480-490.

44. Marek S, Siegel JS, Gordon EM, Raut RV, Gratton C, et al. (2018) Spatial and temporal organization of the individual human cerebellum. Neuron 100: 977-993.

45. Zaglia T, Mongillo M (2017) Cardiac sympathetic innervation, from a different point of (re)view. J Physiol 595: 3919-3930.

46. Ashton JL (2018) Synaptic plasticity in cardiac innervation and its potential role in atrial fibrillation. Front Physiol 9: 240.

47. Shaffer F, McCraty, R, Zerr, CL (2014) A healthy heart is not a metronome: An integrative review of the heart's anatomy and heart rate variability. Front Psychol 5: 1040.

48. Pfurtscheller G, Schwerdtfeger AR, Seither-Preisler A, Brunner C, Stefan AC, et al. (2017) Brain-heart communication: Evidence for "central pacemaker" oscillations with a dominant frequency at ~ 0.1 Hz in the cingulum. Clin Neurophysiol 128: 183-193.

49. Raimondo F, Rohaut B, Demertzi A, Valente M, Engemann DA (2017) Brain-heart interaction reveal consciousness in non-communicating patients. Ann Neurol 82: 578-591.

50. Riganello F, Larroque SK, Ali BM, Heine L, Martial C, et al. (2018) A heartbeat away from consciousness: heart rate variability entropy can discriminate disorders of consciousness and is correlated with resting-state fMRI brain connectivity of the central autonomic network. Front Neurol.

51. Joshi S (2011) Memory transference in organ transplant recipients. NAMAH. JNAMH 19: 40.

52. Pearsall P, Schwartz GE, Russek LG (2005) Organ transplants and cellular memories. Nexus Magazine 12.

53. (2015) Heart transplant recipients' pick-up memories and traits of donors.

54. Miguel N (2012) Beyond boundaries: The new neuroscience of connecting brains with machines and how it will change our lives.

55. Martone R (2019) Scientists demonstrate direct brain-to-brain communication in humans. Work on an "Internet of brains" takes another step.

56. World Science Festival (2016) Mind melds and brain beams: The dawn of brain-to-brain communication.

57. Aspect A, Dalibard J, Roger G (1982) Experimental test of bell's inequalities using time-varying analyzers. Phys Rev Lett 49: 1804-1807.

58. Gisin N (2018) Can relativity be considered complete? From Newtonian nonlocality to quantum nonlocality and beyond.

59. Grinberg-Zylberbaum J, Delaflor M, Attie L, Goswami A (1994) The Einstein-Podolsky-Rosen Paradox in the Brain: The Transferred Potential. Phys Essays 7: 422-428.

60. Hu H, Wu M (2002) Spin-mediated consciousness: Theory, experimental studies, further development & related topics.

61. Futurism (2018) scientists worried that human brains grown in lab may be sentient. Available online at: https://futurism.com/the-byte/scientists-worried-lab-grown-brains-sentient

62. Bandopadhyay A (2020) Nanobrain: The making of an artificial brain from a time crystal. CRC Press, Taylor and Francis Group.

63. Reddy JSK, Pereira C (2016) An essay on 'fracto-resonant' nature of life. Neuroquantology 14: 764-769.

64. Hague P (2019) Cosmic Psyche.

65. Mukhopadhyay AK (2019) Emergence of homospiritualis: of essential requirements-faith, devotion and love: Deep Science of their Psychoneurobiology. Clin Psychiatry 5: 61.

66. Mukhopadhyay AK (2020) Life-form a matters-syncytium: DeepScience for matter correlates of conscious states. ECPP SI.02: 1-16.

67. Mukhopadhyay AK (2012) Information holograph. The structure, the source and its operation. IJMST 2: 12-32.

68. Boros BD, Greathouse KM, Gentry EG, Curtis KA, Birchall EL, et al. (2017) Dendritic spines provide cognitive resilience against Alzheimer's disease. Ann Neurol 82: 602-614.

69. Mukhopadhyay AK (2000) The Millennium Bridge. Conscious Publications, New Delhi, pp: 136-152.

70. Moore M (1999) "Turning Brain into Blood" – Clinical applications of stem-cell research in neurobiology and hematology. N Engl J Med 341: 605-607.

71. LeDoux J (2019) The Deep history of ourselves: The four-billion-year story of how we got conscious brains. Viking. . An Imprint of Penguin Random House LLC.

72. Markram H (2006) The blue brain project. Nat Rev Neurosci 7: 153-160.

73. Esser SK, Merolla PA, Arthur JV, Cassidy AS, Appuswamy R, et al. (2016) Convolutional networks for fast, energy-efficient neuromorphic computing. Proc Nat Acad Sci 113: 11441-11446.

74. Hassabis D, Kumaran D, Summerfield C, Botvinick M (2017) Neuroscience-inspired Artificial Intelligence. Neuron 95: 245-258.

75. Savage N (2019) Marriage of mind and machine. Nature 571: S15-S1732.

APPENDIX

The Table showing different Levels of Cognitive processing:

The Site, the Operator, Involved Information-states and their Geometric shape

Levels of Cognitive Processing	Site of Processing	Cognitive Operator	Information-States	Geometric Shape of Information-States
Signal Processing	Automated Part of Systems Cell, Systems Universe, Nervous Systems	No Operator. Operations have been automated	Digital Information	Frequency
Information Processing	Matter-Cognitive Organ (Psyche) Interface. Within Systems Cell, Signalosome, SMOC (supramolecular organizing Centre)	Application of Mind in no-operator zone	Transformation of Digital to Non-digital State	Frequency structure changing to Trifoliate structure
Thought Processing	Cognitive Organ (Systems Psyche)	Mind	Non-digital Information	Trifoliate leaf
Knowledge Processing	Cognitive Organ (Systems Psyche)	Self	Non-factorizable Information Gödelian Information	Information packages of varying shape Spherical package of Information
Experience Processing	Cognitive Organ (Systems Psyche)	Life	Information Manifold	Stacking of packages of Information
Wisdom Processing	Border of Systems Psyche-Universal Psyche	Consciousness	Information Crystal	Point