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Cognitive Canvas: Molecular Embroidery, Fabric and the Base

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Abstract

Cognition covers the processes from sensation and perception to generation of will and behavioral response by action. The focus of this article is on this cascading depth of cognition, in tune with the depth of nature. The idea has been developed with a metaphor of canvas having a base, fabrics and embroidery,. The paper also focuses on four operations in the cognitive organ, which could also be called systems psyche. Inside the living systems, systems psyche works on the support by molecular signaling network. Ten layers between molecular signal network and the 'will' of the conscious system, such as a cell/neuron, have been described in this paper. The articulation offers an order and direction for research on the thin layer between neuroscience and consciousness along the ladder of cognition. The construction helps connecting psychology and psychiatry with the systems neuroscience and systems biology.

Keywords: *Cognitive Canvas; Inter-Looped Model for Cognition; Systems Psychology; Layers Between Neuroscience and Consciousness*

Introduction

Cognition is a process, which continues in cascading depths. In the literature, this cascade has been traditionally described in layers, such as layers of unconscious, sub-conscious, conscious and super conscious. Or, it has been described as awakening, awareness, experience, choice and decision. What has been lacking is relating this process with recent developments in neuroscience, psychology and natural science (e.g. quantum physics). This paper is largely an opinion/idea of the author on the multi- disciplinary 'big picture', of cognition, described with a metaphor of canvas. A canvas has a base, on which there are fabrics. Both base and fabrics have layers. On the fabrics there are embroidery,; fascinating handiwork on the surface based on micro knitting, which is not always observable. In developing the big picture and establishing his idea/opinion, the author takes helps of the relevant knowledge as available in the literature, which might be called an unsystematic review.

Cognition begins with perception

Cognition is one of the activities, which requires interaction of live conscious systems with the environment. Noise evokes a sensation in the mind. Sensation is recognizing noise of the physical plane by mind. Perception is the first stair in the ladder of cognition. Perception is not a photocopy of the world by mind. Perception is a process of receiving and analyzing the external world by distinguishing signal from noise. Cognition on the other hand, "…….refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered and used" [1]. It includes all processes starting from sensory (and other) inputs into the systems to the execution of action by the systems. Perception at one end and action on the other end in the spectrum of cognition are connected by means of feedback and feed forward loops present within the cognitive apparatus. Perception, although, is not the precise copy of the world around the systems, the process of perception is the beginning of having an experience of the world. While perception relates to signal, concept formation relates to specific information. At the level of hypothesis, it is all coherent knowledge with which a research statement could be made. Theorization demands participation of experience in the cognitive process. A theory is coherent and has explanatory power. It negotiates and predicts phenomenon on the basis of the rules operating in its experience. Experience is, however, systems-confined. Multi-systems concurrence of experience leads to formation of a worldview, which in linguistics is called wisdom. Such cascading loops of cognition have been shown in figure 1.

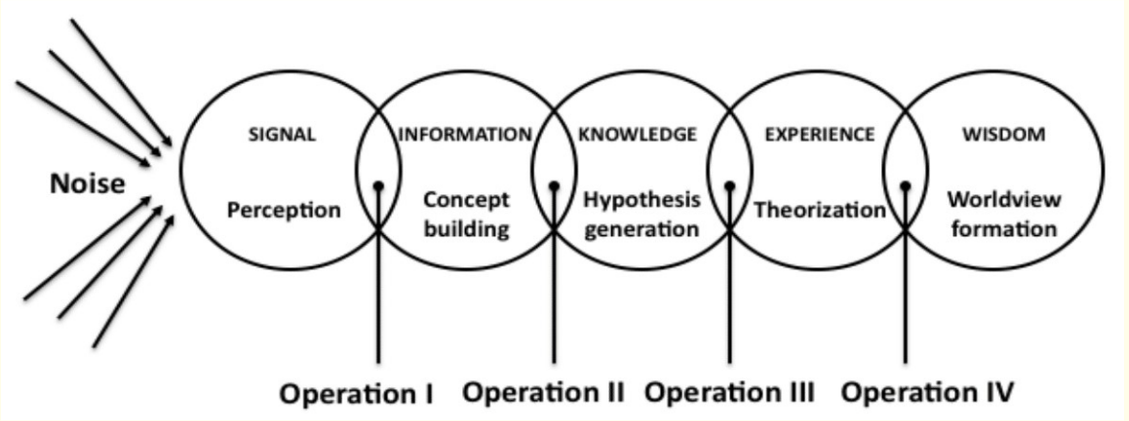

Figure 1: *Loops in Cognition: Cognitive process is interloped to create a caterpillar-like model. It begins with the signal selection from noise and eventually leads to wisdom. Five interconnected loops, respectively of signal information knowledge experience and wisdom, have been shown in the figure. There are four operations in between. Perception, concept development, hypothesis generation, theorization and formation of worldview, therefore, have inter-looped, hierarchically nested connectivity.*

The author has described the model of the ladder of cognition in his earlier paper [2]. In this paper a cascade of loops represent the cognitive process. Inter-looping produces a caterpillar-like model narrating the process from signal to worldview formation. There are four operations as shown in the figure 1. Operation I is involved in conversion of signal into information. Operation II is involved in development of knowledge from information. Operation III shapes experience from knowledge and operation IV builds up a worldview from the manifold of experience. Psychologists might relate operation I with operation of mind, operation II with operation of self, operation III with that of life and operation IV with operation of consciousness. Hierarchically, there is acquisition of new property in every loop. There is no 'intention' in a signal. Information is intentional. Since knowledge is a coherent collective of information it can exhibit sensor property. Experience has predictive power, negotiating capacity and censuring ability. The wisdom is overarching and has governing property.

Systems psyche engaged in the process of cognition

The interface for interaction between the live conscious systems and the environment is the systems psyche, which consists of information, mind, self, life and consciousness. The psyche is not merely mind or consciousness as commonly understood. It has five constituents as ontological entity or as defined specific operation working in a hierarchical manner forming the cognitive organ or the systems psyche [3]. All its elements are non-observable but influential. They are non-local in nature and cannot be localized in space or in time. Let us describe each of the constituents from the exterior to the depth.

The working definition of information could be stated as the unit of communication between two conscious systems. In conscious systems, it is mind, which chooses signal from noise. It is operation of mind, which converts non-intentional signal into intentional information. Information is proposed to have a structural geometry of Trifoliate leaf; its measurable folium is connected with physical world, content folium works with the mind world and the intent folium works with the world of self [2]. This connection with self makes information intentional. Mind is at the forefront of the organ of communication between two conscious systems. Mind, which mostly works with fuzzy logic is, however, not capable of building up of knowledge from information. It is self of the systems, which executes this. What is this 'self'? Self is that which evokes the sense of 'i', 'me' and 'mine' within the system. Self is representative of consciousness, customized to work as CEO (Chief Executive Officer) of the systems. According to Carl Jung, self has central importance but universal distribution. Self has uniting property and orienting role. Self integrates essential drives of brain-mind and leads to instinctual behavioral action and archetypal psychological experience (in, *The Structure and the Dynamics of self*, Collected Works, vol. 9, Princeton University press). Sui and Gu [4] summarize the research of self as an object, by assessing biases towards self-associated stimuli and emergence of a new quantitative paradigm of self drawn from psychology, embodied cognition, neuroeconomics and social neuroscience. This 'self' programs mind for handling signal networking. Self operates with formal logic and itself does network analysis. The process of cognition is incomplete without presence of operating 'life'. 'Life' is observably characterized by the ability of the systems to maintain homeostasis within. Eminent physiologists like Claude Bernard, Walter B, Cannon and Walter Hess developed the concept of homeostasis within living systems. Ho-

meostasis within systems psyche is subtle and could be achievable because of this element of 'life' within the cognitive apparatus. At the subtle level, 'life'-operations execute uncertainty-certainty homeostasis, asymmetry-symmetry homeostasis and according to author, also dark energy-visible energy homeostasis. Dark (invisible) energy constitutes about70% of our universe. It is unlikely that live systems and psyche could function independent of this dark energy. In nature there is continuous transformation of dark energy into visible energy by the living systems. Transformation of signal into information consumes dark energy and the reverse is accompanied by release of dark energy. This is possible because of operation of 'life'. It is also operations of 'life', which shape or design 'experience' from the knowledge architecture developed by self. Experience as manifold has negotiating and predictive power and censuring ability. All mind, self and life work under the umbrella of consciousness. Consciousness could be workably defined as that looks after and is in-charge of what all is going on in autonomously operating mind, self and life, in terms of quality management of information or phenomena within the systems. With operations of self and life, operating consciousness is responsible for awakening, awareness, experience, choice and decision/will. Consciousness supports the autonomous operation of mind, self and life. Consciousness often participates in their activity, rarely intervenes with a view to preserving integrity and wholeness of the systems and regularly indulges in research and creativity, beside its role as an ever-active and alert ground.

In the management hierarchy, mind reports to self. Self and life maintain a tangled hierarchy. Both self and life independently report to consciousness. Consciousness has not to report to anyone but to support and modulate the operation happening on its surface.

Since all of the constituents of the systems psyche are non-localizable in space and in time, their role in systems behavior is missed quite often! The operators are trivially described as 'ghosts' in the machine! In this context, it is worth to remind the reader what Sherlock Holmes told, "There is nothing more deceptive than an obvious fact". What enables the individual neuron of the brain, especially those in the cerebral cortex to have immediate access to the collective, is obviously this organ psyche working from sub-Planckian and sub-sub-Planckian nests of nature. The abstract operations described as operation I to IV are conducted by the non-observable operators as the constituents of the systems psyche. Planck's constants for time and length indicate cognitive limits of human brain at present stage of evolution. This does not lead to conclusion that there is no nature beyond Planck's scale of nature, nor evolution of human brain has stopped (cf., cognitive closure theory of Colin McGinn). "Investigating the Subquantum world deeply, with scientific responsibility, might turn out to be the most rewarding scientific enterprise in the history of mankind's innate exploration drive" (http://www.victorzammit.com/ articles/Klein2.htm, and also the works of Mukhopadhyay, AK, Gerad 't Hooft, Paul A. Lavolette, Gerhard Groessing, Adrian Klein, Robert Neil Boyd and Ram Lakhan Pandey).

Layers in Cognitive apparatus

Cognition is traditionally recognized as a function of consciousness. However, it is not consciousness alone. There are operators like mind, life, self and information. The author develops the view that the labyrinthine apparatus for cognition as described above has ten layers. In a live system cognitive behavior requires system's support at the physical level as signal and at molecular level as molecular signaling. This is the most superficial aspect but at the observable and measurable level of science, while the system's behavior is the output right from the total canvas of organization of systems psyche. The canvas consists of a base, over which there are fabrics. Over the fabrics

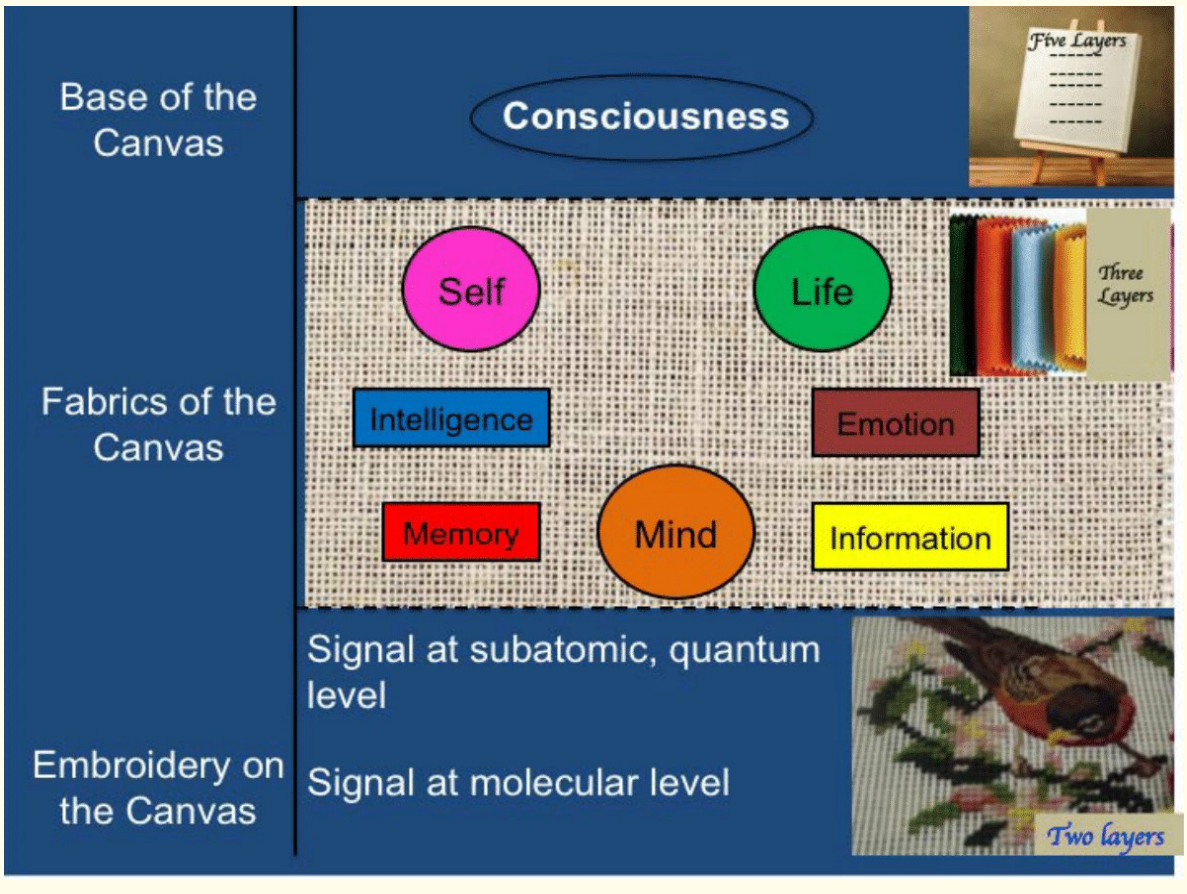

Figure 2: *Ten layers in the canvas of the cognitive organ: Canvas consists of Embroidery, on the surface, fabrics in the middle and consciousness at the base. Embroidery, consists of two layers, fabric three layers and base five layers.*

there is embroidery (Figure 2), which in the context of the paper are signals at the macroscopic and microscopic level.

In the case of systems cell, observable embroidery, on this canvas is the molecular signaling network. There is molecular talk, molecular cross, molecular thoroughfare, molecular highway etc. On the backside of this visible beautiful embroidery, there are interweaving threads at microscopic (may be described as quantum) level, which, however, is the real strength behind the classical scene.

The fabric of the canvas, which has been decorated by this molecular embroidery, has three interwoven layers; the most superficial one is the layer of information, operational mind and the memory. The next deep is the layer of intelligence and feelings (emotion). 'Self' and 'life' of the systems operate from the deepest of the fabric layer. All three layers together form the interwoven fabrics of the canvas.

The base of the canvas is made of consciousness stuff, which for the sake of functional description consists of five layers namely supporting consciousness, participating consciousness, intervening consciousness, creative consciousness and consciousness as unfathomable ground. Supporting consciousness supports autonomous operations of mind, self, life and information and brings coherence in those autonomous activities. The systems remain awake! Once there is coherence, participating consciousness makes 'self' aware of the contents of consciousness and offers, if necessary, advice and suggestions to those autonomous operations regarding maintaining 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 not

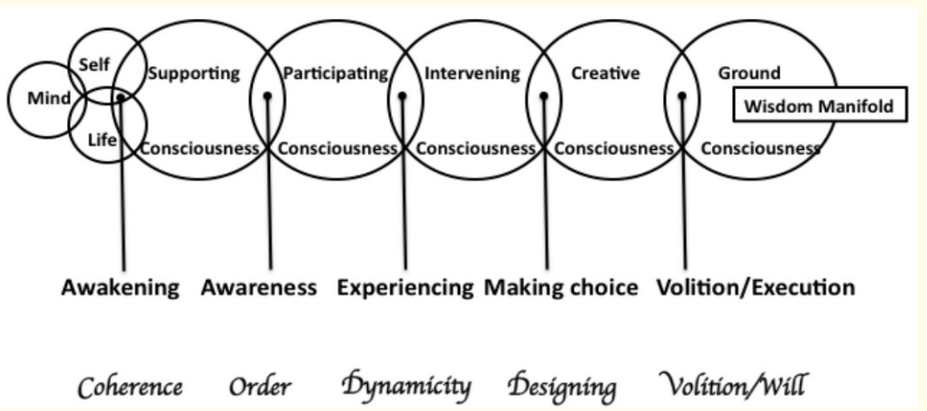

Figure 3: *Five layers of the base of the canvas of the cognitive apparatus: The picture looks like that of a caterpillar, with wisdom in its tail and the mind in its front. Supporting consciousness supports autonomous operations of self, life and mind and brings coherence in the whole scenario. Participating consciousness looks after and maintains the required order. Dynamically intervening consciousness censures and maintains integrity of the systems. Creative consciousness designs and opts for best choice. The will/volition and action spring from the ground consciousness, which is stuffed with wisdom manifold.*

at all inert. The ground consciousness is active and stacked with wisdom arranged in manifold. Decision/will/volition of consciousness springs from this deepest layer of the base of the canvas (Figure 3).

Awakening requires interloping of consciousness, self and life. There is emergence of coherence. Awareness of the contents of consciousness is associated with observable order or its absence in the contents. Experiencing is associated with dynamicity and designing is associated with choice. How the coherence as described here, could be related to "singular transitions in the cortex modeled as coherence-decoherence switches described by quantum field theory (QFT)" in Walter Freeman's neurodynamics [5] merits further research. In bottom-up approach, QFT is confronted with the problem of Infinity. Top-down, quantum fields could be considered the messengers of Infinity (read consciousness).

Without operation of each layer of consciousness as and when required, such as support, participation, intervention, creative choice and volition/will/decision from the wisdom-manifold, autonomous operations of self, life, mind and information cannot run the signal network at the physical molecular level. On the other way round, bereft of any functioning of such molecular/physical signaling network, it is never possible to translate the will/creative choice/intervention/participation or even the supporting skill of consciousness of the systems into a classical sensible observable behavior.

In the following section, we will first discuss examples of molecular cognition, the molecules involved in cellular cognition and finally the molecules in the context of cognition by the brain. Finally, we will again revisit the canvas in terms of interconnected and hierarchically nested world of loops.

Molecular cognition

Do chemical molecules have demonstrable cognitive property? Perhaps yes, but to a very limited capacity! Is sensing a part and parcel of cognition? At the physical level, for example, coherent laser beam has sensing property. The property has been exploited in low-level robotics (e.g. automated door). Similarly some chemical molecules also exhibit sensing property. According to some scientists, sensing should be considered a preliminary property of the cognitive process. Then, molecular cognition remains an example of very very limited cognition. Molecular cognition exhibited outside a living system amplifies significantly when the molecules ensemble within a living cell. This all could happen within a cell because of a preliminary step by mind and self in the cognitive apparatus to convert non-intentional signal into intentional information. Let us examine the issue in a bit detail.

A molecule of urea or glucose, creatinine or uric acid does not have any cognitive power. They are non-informational molecules. A chain of several amino acids, which makes a polypeptide molecule, can carry a message. Many polypeptides work as signal molecule. Still, it is not strictly an informational molecule. It is without any intention. Informed molecules, because of their specific structural conformation, have information carrying capacity. Receptor molecules in the cell membrane belong to this category. We see such cognitive properties are expressed in the folded protein molecules, which act as 'receptor' molecule on the cell membrane. Proteins with tertiary structures are 'knowledgeable' proteins, which exhibit sensor property. There are plenty of examples of sensor molecules within the cells. For example, Caspase 11 acts as a sensor for cytoplasmic LPS [6]. The protein of inflammasome such as NLRP3 is sensor for pyroptic and necroptic pores [7]. NLRP6 is also a multifaceted innate immune sensor [8]. As there are infinite varieties of knowledge (and experience), so there are similar numbers of symmetry (and super-symmetry) in protein structure. There are proteins with quaternary structure, which are very 'experienced' protein and mostly involved in vital work like oxygen-carrying (hemoglobin), specific killing of foreign cells (perforin), or involved as repairing enzyme (DNA-repairing enzyme). All these proteins have censuring property. Small HSPs have multimeric crystal structure [9], which with other heat shock proteins censure misfolded proteins. Discussion in most of the textbooks stops at quaternary structure of protein and do not go beyond this. However, there is a special group of proteins, which are spherical in structure and have the capacity even to drive DNA function. They may work as DNA Driver [10,11]. These are histones present in the nucleus. Histone is a multimer of spherical proteins involved in 'regulating the regulators'. We might call it 'wisdom' protein. DNA strands coil around this spherical histone, which works as the final common pathway for epigenetic influence. As within the cognitive organ, mind has hotline connection with consciousness, so also within systems cell, lipids of the cell membrane (the main seat of mind) speak directly to histones [12]. This new taxonomy of proteins opens up a new area of research for cyber-semiotic discipline. In developing a bio-hybrid robot, whether it is possible to inculcate such properties of protein molecules is a matter for further research.

The examples of molecular cognition by protein as described above are in a live-environment. Whether the non-protein molecules in a live-environment exhibit such cascade of cognitive properties merits investigation. In a non-living environment, in absence of operation of 'life', the cascade of cognition cannot go beyond limited self-organization of physical force or chemical molecules. Molecular cognition outside a live system can go up to acquisition of 'sensor' property. Presence of operation of life within the systems brings an altogether different scenario for protein molecules, with acquisition of additional property of intentionality, negotiation, censuring, prediction and finally the ability to govern.

Molecular cognition as described above is far limited as compared to cellular cognition as described below.

Cellular cognition

Molecules engaged in the process

Cellular cognition is an emerging discipline. That a unicellular organism or cells in multicellular organism have cognitive property is documented in several research papers. Any entity, which has in its possession operations of mind, self, life and consciousness, must have a cognitive unit. All mind, self and life have representation or extension at the cell biology level. We are looking for molecular correlate/correspondence/substrate for cellular cognitive activity [13]. The mind of a cell is reflected in activity of its ion-channels. For stimulus-excitation coupling responsible is sodium ion channel. For excitation-contraction coupling important is calcium ion channel. Both ion channels represent mind at the biochemical level. When a two-three year old baby develops sphincter control, he is understood to have his own mind. As long as an unconscious patient has his mind working, he does not pass urine or stool on the bed. Sphincters are controlled by calcium ion channel. Calcium ion channels are important for regulation of blood pressure. Persistent disturbance of mind is one of the reasons for hypertension, which is related to calcium ion channel disturbance. During fertilization of the ovum with a sperm, where minds of two opposite sex meet, Ca^{2+} channel plays very crucial role. Calcium-wave in the astrocytic network of cerebral cortex supports activity of mind within the brain [14-16]. Calcium ion channel disturbance has come to focus in research on dementia where there is deterioration of mind function. Zaichick., *et al.* have reviewed [17] the role of Ca^{2+} signaling in second most common neurodegenerative disorder like Parkinson's disease. The molecules for mind are abundant in cell membrane, which has been compared with a liquid crystal semiconductor with gates and channels [18].

As ion channels represent mind, so the ion-pumps represent the ionic self at the biochemical cellular level. Unlike ion channels, which are energy independent and mostly passive, ion pumps are energy dependent and require expenditure of ATPs. For comparison, within the psyche mind keeps on operating passively but self's intervention is always active. Self could control mind. Mind reports to self. Ionic identity of self started with genesis of unicellular bacteria at the hot vent of deep sea within salty-water. Cell's membrane potential determines the identity of self, which is a result of functions of various proton pumps. Later on, in the course of evolution, self-evolved biochemically to be represented by MHC molecules. This came into existence for defensive acts to counter attacks by other pathogenic organism or virus. The whole immune system is understood to work on the basis of this self/non-self distinction (since the theory of Burnet in 1940s). Now according to an emerging theory, immune system is said to work on 'discontinuity' of self [19]. Depression and immunity could be linked easily with this kind of research hypothesis.

Life processes are distributed biochemically all over within the cell. Messenger RNA (mRNA) molecules involved in various protein synthesis represent the lifeline of a cell. Hundreds of microRNAs (miRNAs) that help sculpting the expressions of most mRNAs [20] are the distributed 'life'-molecules for cell. Function of 'life' is to maintain homeostasis of the systems, the theory that overarches neural, endocrine, metabolic and defense management of the systems. The most crucial function in the context of 'life' is represented by the proteins at the junction of cytoskeleton with the cell membrane. The cytoskeleton dissociates from the membrane seemingly in two situations, when the cell is going for division or for apoptosis. Another most crucial protein regulating 'life' molecules is the histone. Histone is a spherical protein within the nucleus of a cell and in this sense it has a unique architectural design for packaging of important substance. Majority of epigenetic signals subsequent to life-style changes work through this histone.

The cell feels various kinds of stress. For examples, genotoxic stress, metabolic stress, oxidative stress, endoplasmic reticulum stress and apoptotic stress. There are stress-adaptive mechanisms within a cell such as slowing of cell cycle, down regulation of housekeeping functions, activation of protective pathway e.g. through heat shock proteins and as shown in stress-triggered phase separation within a cell to 'gel or die' [21].

The possible molecules carrying the feelings and emotion within the cell could be the cytoskeleton, which connects various cell organelles with the cell membrane. Feelings and emotion could not be digitized and the signals move in bulk. Structures of microtubules are very much conducive for information conductance and storage.

The signals received by the cell membrane could be categorized into two groups (Table 1), those distributed through cytoskeleton and those distributed through cytosol.

Cytoskeleton mediated Signal distribution within a cell	Cytosol-mediated signal distribution within cell
It could be called an information highway	As if it is sailing information through sea-route
Mostly non-discrete 'emotional' messages are transmitted through this route	Mostly discrete, 'intellectual' messages are sent through this sea route
A very rapid method of transport	Slow process
Message delivered to most of the cell organelles	Message delivered to specific cell organelle
Inside nucleus, most of the signals are transmitted to non-DNA chromatin	In the nucleus most of the signals are transmitted to DNA
Examples: Signals for cell division, apoptosis, cell cycling, phagocytosis etc.	Examples: Transcription signals, autophagy signals, metabolomic signal etc.

Two routes have been sketched out in my earlier publication on the ladder of cognition [2]. The sketch is reproduced as figure 4 below.

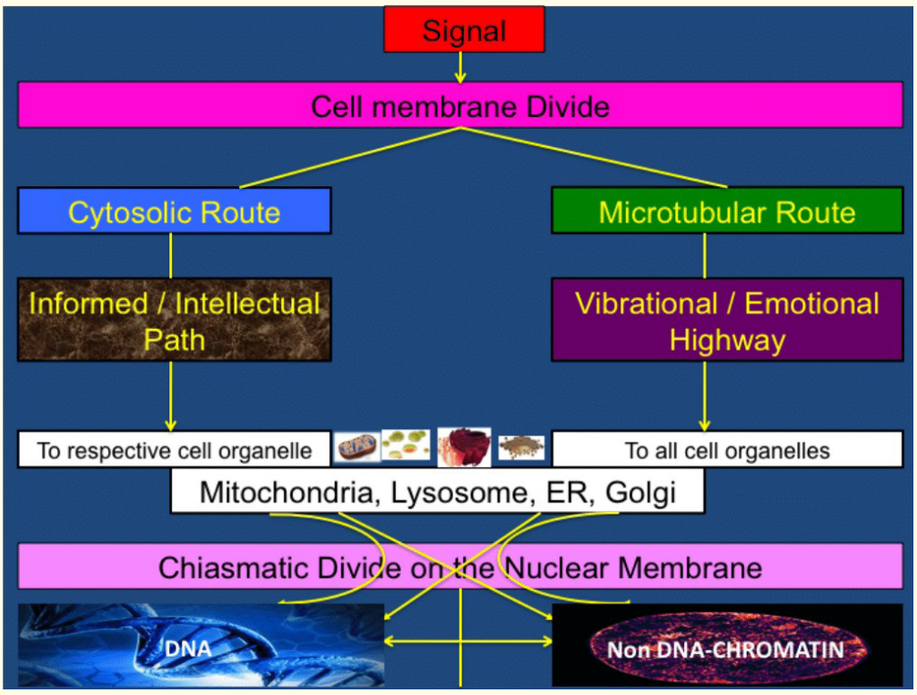

Figure 4: *Two information communication routes within the cell: The route through cytoskeleton is an information highway, high speed, conducts message to all important organelles of cell. Mechanotransduction at the cell membrane-cytoskeleton junction and microtubule-nuclear membrane junction is important in this route. Most of the information interacts with non-DNA chromatin of the nucleus. Cytoplasmic sea-route is slow and is for discrete message transmission to specific cell organelle. Most of the information work with the DNA of nucleus.*

Mechanotransduction at the cytoskeleton-cell membrane junction and cytoskeleton-organelle-membrane (particularly nuclear membrane) junction is very vital in this context. Cytoskeleton has a major role in nucleo-cytoplasmic transport and vice versa. Catabolic pathway like autophagy requires cytoskeletal coordination. In neurodegenerative disorders while autophagy essentially fails, Baron., *et al.* have [22], reported switch over of autophagy-lysosome pathway to nucleophagy-golgi pathway, which leads to neurodegeneration. How cytoskeleton could be responsible for this switch over merit further research and this might lead to a fundamental breakthrough in cell signaling. There is now a trend in cell biology to prepare the minimal parts list for the microtubule-organizing centers [23]. Collective microtubule organization of the billions of neurons inside the brain could be related to the levels of consciousness of the being.

Cognition by the brain

Molecules engaged in the process

General consensus in science is that the brain is the organ of cognition. This is true for all except cognition in the brain-less animals. The basis for such consensus is that cognitive activity such as attention, concentration, memory, acquisition of information, developing it into knowledge, are seriously disturbed in brain trauma (concussion, contusion and tissue laceration), inflammatory condition of the brain and meninges (encephalitis, meningitis), vascular stroke, general deficiency state (Korsakoff's psychosis), metabolic conditions (hypoxia, hyper and hypoglycemia, electrolyte imbalance etc.), neuro-degenerative conditions (like Alzheimer's disease, Parkinson's disease), psychiatric disorders like stress, anxiety, unreasonable anger and depression. In some physiological conditions such as sleep, emotion and exhaustion cognitive activities remains low. As self is essential for cognitive activities, appropriate supportive functions of sub-cortical midline structures (SCMS) of the neuraxis are minimally required for cognition.

Etiological factors for the conditions as described above, fall into three groups; (i) Signal Network (ii) Neuro transmitters in the synapses and (iii) Cellular factors.

Signal Network: Network amongst hundred billions neurons of the brain is a live network. All neurons and their supporting glial cells are alive. Brain network cannot be anyway compared with that in the artificial state (AI) popularly known as 'neural network'. Signal network within the brain involves hundred billion neurons arranged in horizontal and vertical disposition. Horizontal disposition at macro level has created left and right cerebral hemispheres. Vertical disposition of neurons, following an evolutionary hierarchy has created brainstem, diencephalon and cerebral neocortex. Within the neocortex inter-connective networking is extensive and complex. The sci-

ence of networking within the brain is still in its infancy. However what emerges straightforward are presence of segregated communities of networks as subsystems of the entire network. Subsystems correspond to functionally specialized functional areas of the brain [24]. Genon [25] has recently reviewed how to characterize the function of a brain region.

Neurotransmitters: Many synapses inside the brain are electrotonic and many synapses work through chemical neurotransmitters. In the systems brain, chemical synapses are tripartite with involvement of equal or double the number of astrocytes. One astrocyte is connected with thousands of synapses even across the hemispheres. There is metabolic shuttle of lactic acid, glutamine and ATP from astrocytes to neurons. Without calcium wave across interconnected astrocytes, there is little operation of what we call operation of mind. Signal to information and information to signal transformation occur in the neo cortex because of 'dark energy-visible energy' homeostasis maintained by astrocytes.

Eight neurotransmitters have been found most abundant within the brain and are relevant in the neural perception to cognition. Norepinephrine, acetyl choline and gamma aminobutyric acid (GABA) directly contribute to awakening and alertness. Glutamate is an excitatory neurotransmitter. Cognition is not isolated from activity of mood and feelings. Dopamine and serotonin levels are related to status of mood. So also important are the levels of two more neurotransmitters; oxytocin and endorphins. Dopamine, serotonin, oxytocin and endorphins are four neurotransmitters related to feelings of happiness. Subtle disturbance of these neurotransmitters either in production, or in metabolism or by modulation of extraneous chemicals and drugs lead to disturbed perception and cognitive activity.

Neurotransmitters have been classified in different ways; according to size, (small or large), according to their chemical nature like amine, amino acid etc., or whether the chemical vesicle is electro-lucent or electron-dense. The present author has tentatively grouped these neurotransmitters as molecular representatives respectively of mind, self, life and consciousness [3]. There is a massive task ahead to finalize this draft.

Intracellular disturbance: As mentioned earlier, not only neurons but also astrocytes, the glial cells, which nourish neurons and protect neurons from dark energy, are equally important for cognitive activity. Common causes of acute cognitive disturbance are intraneuronal edema, and chronic cognitive impairment is caused by neuronal/astrocytic degeneration. As mentioned earlier, intracellular and intercellular calcium wave in the astrocytic network could be correlated with operation of mind in the process of cognition.

Thin layer between neuroscience and consciousness

How a physical signal could alter the behavioral "will' of the systems and how the will of the conscious systems is eventually displayed as signal is a new horizon of research. No one has any clue on it. In Cook and Damasio's paper [26] we get some good attempt towards this direction; sensation, perception cognition, volition and behavior. In author's three papers published earlier [2,27,28], the ladder of cognition has been followed and a workable model from sensation to perception, concept formation, hypothesis generation, theorization and worldview formation has been proposed. The layers could also be described as cascading stairs of the processes working between causal push from the bottom and teleological pull from an apparent virtual attractor (consciousness) at the top. By exclusion of the presence of such pull from the virtual attractor of consciousness, computational neuroscience is sure to face what Stuart Kauffman has described as catastrophe of complexity.

Receiving sensory (noise) inputs is followed by signal computation (encoding, decoding recoding) according to Boolean logic. It results in perception. Next step is seen as information on the board of mind, processed by fuzzy logic. There is concept formation. Following this, there is concordance on symmetry and emergence of knowledge architecture, developed by formal logic. For experiencing the design conveyed in the sensory inputs, geometry and symmetry developed over information manifold has to concur with neural manifold engaged in such experience. Inferential logic works here. At this point comes consciousness's accord. This will of attention structurally organizes the center (consciousness) and the periphery of the whole cognitive process and thought, and makes 'self' ready to have choice. Volition follows the choice to result in behavioral action. The cascade figure (Figure 5) has been reproduced here from author's earlier publications [2,27] for the convenience of the readers.

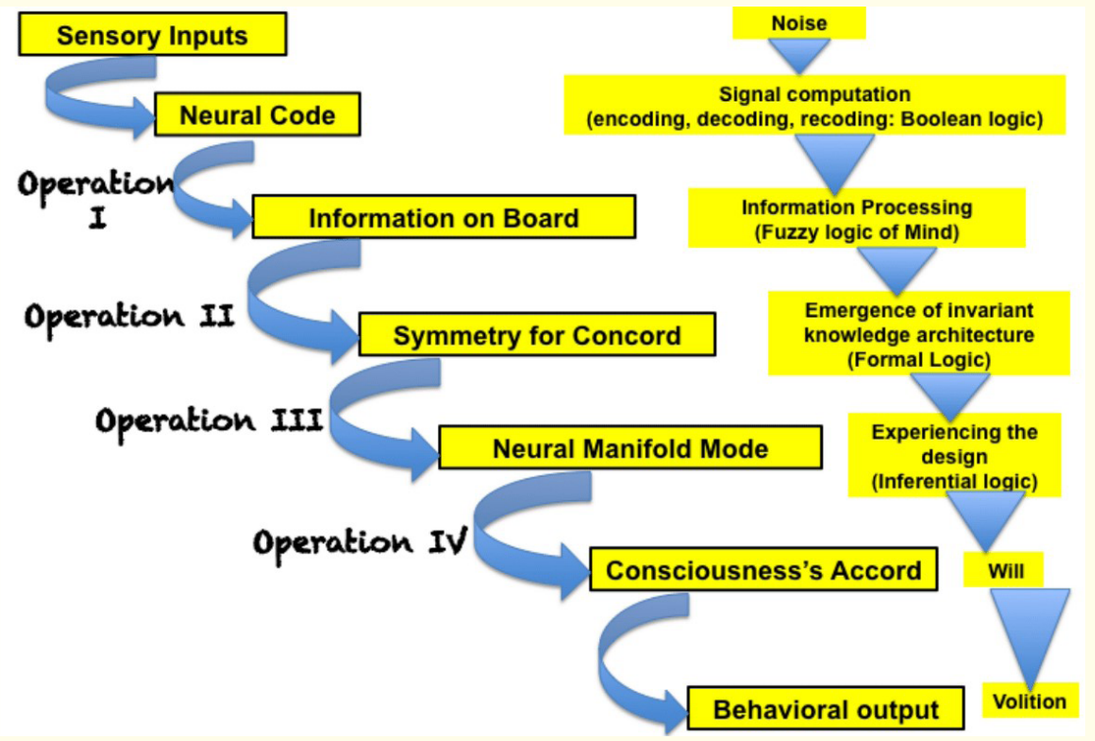

Figure 5: *It shows the cascade from sensory inputs to behavioral outputs. The cascade is self-explanatory. Shown on the left side are sensory inputs, neural coding, information on the board of mind, development of a symmetry concord, involvement of neural manifold, delivery of accord from consciousness and the behavioral output. Various logic operating on the cascade are shown on the right side. Four operations, which are effecting this cascading, have been shown on the extreme left.*

According to the presented scheme of happenings, there is involvement of operation of 'life' during conscious experience with a communication between brain-bound and brain-independent consciousness, neurologically by means of cortico-supracortico and supracortico-cortical communication. Conscious experience, however, is supported inside the brain by a large-scale neurodynamics in neural manifolds extending over the whole of the vertical brain from glia-dominated 'thinking' cerebral cortex to medulla oblongata lodging vital respiratory centers, cardiac center and vasomotor center, and most of the horizontal brain covering left and right cerebral hemispheres. In this sense of open-endedness, our proposition is outstandingly different from all metastable theories of consciousness such as Global Workspace Theory (GWT) [29], Dynamic Core Hypothesis (DCH) [30], Operational Architectonic Theory (OAT) [31], and Default Space Model (DSM) of Consciousness [32], all of which are limited by the boundary of brain-confined, brain-caged, brain-bound consciousness, all of which suppose that consciousness is outcome of cooperation, coordination, synchronization and harmonization of oscillation frequencies of the complex multiple neural ensembles. Had the assumption been correct, all machine learning devices, deep learning devices and supercomputer would have been conscious by now!

There is something wrong in the basics. Perception, knowledge, ideas or thoughts are not conscious experience. Synchronization of oscillation of fields/frequency at best could lead to clash, annihilation, concurrence, merger or resonance between perceptions, knowledge, ideas and thoughts. Such synchronization and harmonization do not have the ability to generate conscious experience. During generation of conscious experience, the brain passes through a phase of critical instability. There is momentary shut down of brain consciousness followed by instantaneous communication with brain-independent consciousness. This cannot happen without operation of 'life'. At the physical energy level, synchronization of field/frequency could eventually lead to Zero Point Energy (ZPE), across which the road to Infinity (conscious experience and consciousness) begins. 'Life' operates across ZPE and is responsible for transforming dark energy into visible energy. Neuroscience could recall the role of astrocytes at this juncture.

The layers between signal frequency and 'will', and those between 'will' and signal frequency, therefore, cover the perception-volition cycle. The cycle is not merely one circle but could be described as several circular loops in phases (Figure 6) operating from the sub-Planckian and sub-sub-Planckian nests of nature.

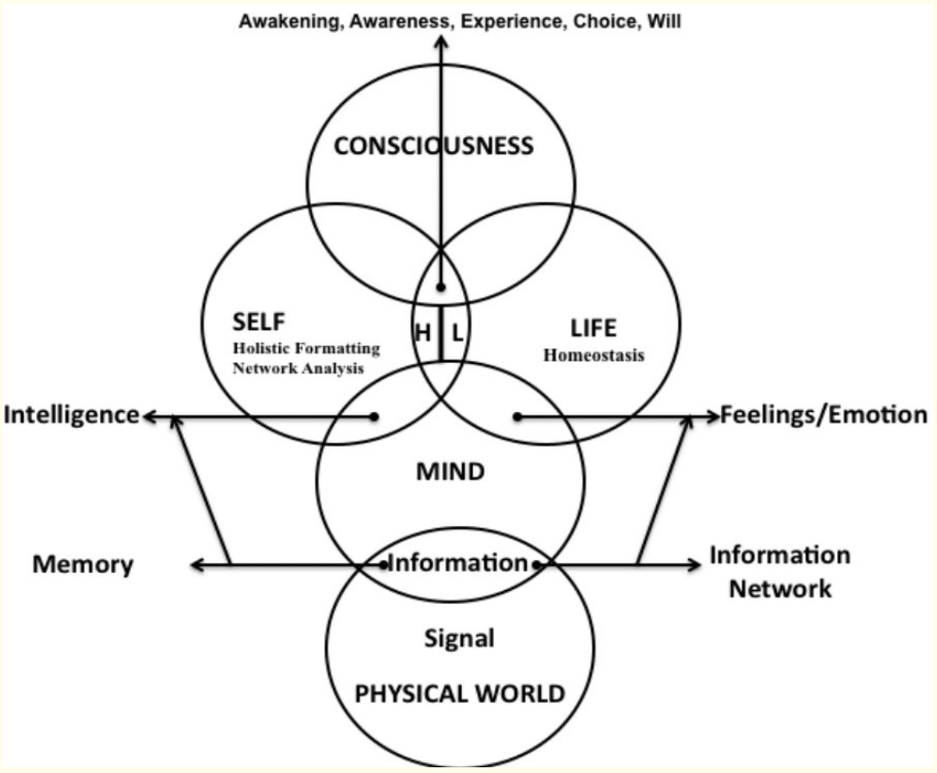

Figure 6: *Worlds of Loops: Physical world loops with the loop of Mind, which in turn intersects with loops of Life and Self. Loops of Self and Life intercept with loop of Consciousness. Loop of Mind has no intersection with loop of Consciousness. However, Consciousness has a hot line (H L) connection with Mind to reach the physical world. Life and Self also reach physical world through Mind loop. Feelings/Emotion are outcome of interaction between Life, Mind and Information, while Intelligence is an outcome of interaction between Self, Mind and Memory.*

Loop indicates circularity. Every loop is independently infinite. Areas of their interception are event horizons. Only the loop of consciousness breaks open the circularity and remains open to its fathomless base which in the linguistic might be called wisdom manifold (Figure 3). In the context of neuroscience, this is the point of the brain, which is open supracortically.

The loops as described in the figure are beyond the measurable scale of present science except the loop at the bottom, that of physical world. How the disciplines of synergetic of Hermann Haken [33], complexity and neurodynamics of Walter Freeman [34] intercept with the loop of mental world or loops of life, self and consciousness are yet to be explored. The discipline of cybersemiotic in this regard has potential to contribute in demystifying this horizon. Another interesting feature of this construction is that both kinds of model, the model of the brain as multileveled predictive processors ending in Bayesian inference, and the UC model of the brain which deals with Unitary (one interpretation at a time) and Coherent experience (where parts not contradicting each other but relating to a goal) [35] are explainable with the inter-looped model of psyche presented here.

Concluding Remarks and Perspectives

The whole process of cognition has been described following author's earlier published paper on the ladder of cognition. In the process we have revisited the system psyche, the cognitive apparatus. Total canvas of the cognitive organ has been demystified. Its ten layers have been delineated; two layers visible as embroidery, three layers as the fabrics and five layers as the base of consciousness. It would be interesting to see how with this model the psychologist could explain the phenomena such as inner voice, inner speech, inner experience, writer's block and procrastination etc. Also, the thin layer between neuroscience and consciousness has been revisited and explored in terms of interconnected loops. However, how the disciplines of neurodynamics and synergetic could be connected with this interlooped complexity is yet to be seen. This truly multidisciplinary paper retains the potential to revolutionize psychology and psychiatry. It brings psychology and psychiatry in continuity with systems neuroscience and systems biology. The way has been laid down how psychology and psychiatry could be connected with molecular cell biology. There are enough materials in the paper for nourishment of cybersemiotic discipline. Further, the scientists working on artificial intelligence and artificial life might find this construction useful for their field.

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