Consciousness is the Central one in a Five-piece puzzle

Asok Kumar Mukhopadhyay, MD
Department of Laboratory Medicine
All India Institute of Medical Sciences
Ansari Nagar, New Delhi-110029
E-mail: mukhoak53@yahoo.com

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Abstract

The issue of consciousness which has baffled the philosophers for hundreds of years is not monolithic but a five-piece-puzzle, understanding of which is a prerequisite to hold the bull by its horn! Disentanglement of the issue of consciousness which is inextricably connected with the operations of 'life', information, self and mind, seems possible if we work on operational mechanics of consciousness and try to connect it with quantum and classical mechanics through mechanics of information.

Keywords
Consciousness, Mind, Self, Life, Information, Operation

Introduction

The issue of consciousness consists of a number of puzzle pieces which make it difficult to get into it its bones! How consciousness is relevant for life? Is there any difference between what we call mind and consciousness? How self is related to consciousness? How the organization of life differs from self-organization? How the operation of self is different from that of mind? Where does information fit in this puzzle? How all are relevant in science? The topic has broad interest to almost all main disciplines of science; life-scientist, psychologists and psychiatrists, neuroscientist, cognitive and information scientists, quantum physicist, social scientist to name a few. However how to approach the subject to everyone's satisfaction has remained a dilemma.

The focus, I admit, cannot be brought up appropriately only from insights that come from data in biological and material research. It also requires connecting insights from intuitive mind to piece together some of such insights. During connecting, the speculation of intuitive mind should certainly offer some direction for future research. The essay has been build up on these three pillars – (i) insight from scientific data (ii) speculation of intuitive mind, with (iii) some concrete propositions for future research.

In this paper, first it is emphasized that consciousness-puzzle is not monolithic. It has five pieces in the whole puzzle, each of which belongs to one or other paradigm of science. The pieces are Life, Mind, Self, Consciousness and Information, all of which except the last, cannot be strictly localized and are therefore `nonlocal' and appear fictitious. However, we are familiar with their role when we analyze the series of operations form sensation to consciousness. Operations could be subjected to scientific enquiry. In other words, this makes the subject relevant for science.

Scientific insights in construction of this paper have been taken from some recently published works like (i) Epigenome consolidating and stabilizing cognitive-behavioral memory (Day and Sweatt, 2011), (ii)Candidate mechanism for experience-dependent changes in transcription of genes (Chen et al, 2003, Weaver et al, 2007, and Borrelli et al, 2008), (iii) Neuron-glia partnership and role of astrocyte in consciousness research (Oberheim et al, 2006, Panatier et al, 2006, Banaclocha, 2007, Halassa et al, 2007, Alfredo Pereira (Jr.), 2007), (iv) Insight from experiment on nonlocal behavior in brain (Grinberg-Zylberbaum et al, 1994). In addition, there are (v) insight from known facts on self-organization and 'life'.

Intuitive insights and *speculation* have helped to construct a connection between independent but interconnected operations of mind, self, life, consciousness etc. which has been depicted by a self-explanatory electronic colored diagram.

Propositions in the article are based on explanatory gaps and therefore on insights as necessary for filling up those gaps. Relevant questions which science can take up have been raised in the proper context. Five concrete directions have been articulated on the paragraph on information.

In *conclusion* the paper highlights the epistemic consciousness over consciousness as ontological entity and spells out the real difficulty in addressing the issue. A possible way out has been shown to carry forward the search for the solution.

The Chain of operations for conscious Experience and its Response

To strike the right chord of consciousness, let us analyse the milestones in the pathway from sensation to consciousness which consists of several operational steps. Each operation belongs to one or the other discipline of science, thus making the consciousness study a multidisciplinary endeavour. The process begins when a physical energy (light, sound etc.) or chemical energy (e.g., in taste bud) stimulates the peripheral receptor. What the nerve conducts to the central neuron is an electrophysiological impulse called action potential, an all or none response, or a graded potential, intrinsic oscillation or a plateau potential. Discovery of plateau potential in RMD neuron of nematode C. *elegans* opens the possibility of digital signalling in central nervous system (Mellem et al, 2008). The cell body receives this impulse/signal but can recognize it as a distinct one only by its pattern (space/time) and rhythm. This, although, alters the body language of neuron as a cell, the question remains how any information is generated out of this pattern and rhythm of physical energy? The question also is where in the neuron this information is sorted out along with other information it receives? The question is how the meaning of this information is extracted? Once the meaning comes out of this information, what in a cell experiences it? How this experience is further distributed throughout the cell on the basis of which a response can be executed from the `whole' of the cell?

Let us look at the possible answer to all such questions: not very easy job. At present we know only a few milestones on the way like, mind, self, consciousness etc. We would be stuck on the very first question for several years on whether there is real time transition of pulse of physical energy to information or it is a phenomenon of correspondence with an operation of matching of signal with existing information in memory which implies prior learning. From energy to fields, or a space-time construct with a rhythmical pattern and then a resonance with information, surely it needs a mind-like structure and process at the end-loop of the string. Mind is also involved in sorting out and prioritization of information. Meaning extraction would be an operation of mind executed by 'self' in a self-organizing system like neuron! One

who experiences it is self. Execution of decision in response to this experience requires the distributed consciousness to be taken into confidence. How the consciousness is distributed throughout the organism? The insight comes from the work that the candidate mechanism for experience-dependent changes in transcription of genes is the information-carrying molecules for epigenetic mechanism (Chen et al, 2003, Weaver et al, 2007, and Borrelli et al, 2008). Epigenetic is which can bring mitotically or meiotically heritable changes without any change in DNA sequence (Bird, 2007). The role of epigenome in consolidating and stabilizing cognitive-behavioural memory has been reported by Day and Sweatt (2011). This is particularly important in a cell like neuron which does not replicate but persistently has to cope with multiplicity of signals for response, regeneration and plasticity (Meaney & Ferguson-Smith, 2010). Besides the distributed consciousness along the network of informational macromolecules, metabolome-proteome-epigenome-genome, in systems biology there is another phase of consciousness which operates as overarching consciousness to maintain the harmony of all organelles, network of informational macromolecules, and their soft-ware-equivalent like, mind (**LINK** Fig. 1). Overarching consciousness, a phase different from consciousness as the summated and integral of the distributed consciousness, operates for the coherence in the system without which any or all individual operations may go independently autonomous, free-rein and chaotic. In addition, the decision the system takes becomes self-contradictory leaving a schism between self's experience and will, and the cumulative experience of the whole and its will. Over and above this distributed consciousness and a conscious self, the operation of overarching consciousness is essential to avoid a situation of divided self. It is this overarching consciousness which incessantly executes creative operation to make up situations for the cell to live amidst countless informational and phenomenal inputs. This is what makes consciousness relevant in science.

Following what has been said, one can understand why there are two approaches to study consciousness; matter-based study of consciousness with a bottom-up approach and a top-down approach of consciousness-based study of matter-energy. However, in both approaches what is conspicuous by a miss is the role of 'life'. Are all these operations possible if the cell, neuron, were not alive! Would all these operations be successfully conducted in an inanimate substance? Without life, is ever generation of information possible? Beside 'life', what else has so much power of organizing information? How life is involved in this chain of operations is not clear. However, without 'life' these operations cannot be executed with such perfection! For a scientist, consciousness and mind are prerogative of only living organisms. Therefore, from sensation to consciousness we find several apparently independent but interconnected operations; operation in the physical world, operation of mind, operation of self, operation of life, operation of information and operation of overarching consciousness.

Analysis of the Operations

We may first focus on mind and self in consciousness-puzzle. That mind has an operational mechanics has been advocated by philosophers of mind and is also acknowledged in psychology and psychiatry in disorders of thought and mood, while no such utterance on self having an operational mechanics could be found in the literature except a passing mention in self-organization paradigm. Life-form is certainly a self-organizing system. "Self-organization is creation without a creator attending to details", said Bremermann (Bremermann, 1994). Self could be said as categorically identical with consciousness of which it is informationally conditioned operational unit for the system. Self is that which programs information processing, makes choice independent of algorithmic pre-specification, analyzes intelligence-input, takes decision, experiences phenomenon and retains the experience in memory (episodic memory). Mind, on the other hand, is categorically different from consciousness, sensitive to information, capable

of processing information as programmed by self and retains memory of information (semantic memory). Mind has no room in material monism or consciousness monism and is necessary in situation of duality where it acts as an organ of communication between two conscious systems; whether the two systems are within the cell or the communication happening in between two cells. Mind, therefore, does not have independent existence. It is unlike the situation for self. Any unicellular organism or any cell of multicellular system has a self of its own and a mind of its own by which it interacts with phenomenon and information respectively. However, the seat of self or mind cannot be localized spatially as well as temporally. In this sense, self and mind are both nonlocal. So is also consciousness. Information too can behave in both local and nonlocal way. The insight of nonlocal behavior in brain function comes from a seventeen year old publication titled, "The Einstein-Podolsky-Rosen Paradox in the brain: The transferred potential" (Grinberg-Zylberbaum et al, 1994). Here, we are confronted with a situation where the two titans, local and nonlocal science meet. However, the consciousness-category self has a local material representation as molecular self, on the basis of which the whole immune system works against non-self. The molecular equivalent of mind, however, is not that concrete. Nevertheless it can be tried in the organized membrane-proteins which are informationally connected with the epigenome-genome of life-system.

Life as is known in science begins with life-form having properties of autopoiesis, ability to inherit its nucleic acid sequence and ability to evolve being coupled to environment from which it accumulates free energy (negentropy) and which it influences to its own favor. It must have uncoupled reaction to explain its spontaneity. As a `living state' of matter, there is an organized coherent activity of DNA, RNA, enzymes, information-carrying macromolecules in which *photon*, to speak in the language of quantum biophysics, carries the signal with speed and transparency, *phonon* maintains the rhythm, *conformon* works in conformity with the whole and *neutrinos* maintain openness of the self-organizing cell system. In the Worldview of consciousness, 'life' is said to be the currency with which consciousness operates its mechanics. What is not known is why development of consciousness is seen only in living organism? How organization of life is unique and differs from self-organization? How, in contrast to inanimate object, living organism generates information and organizes information?

Information, although, is universal *lingua franca* of the present age it means differently to different discipline of science. Shannon originally defined information as that which reduces uncertainty. Chance, in this sense, is antithesis of information. While the capacity to acquire information is directly related to uncertainty the organism lives in, the capacity to organize information is a function of consciousness not directly but indirectly through operations of 'life' and 'self'. A broad consensus can be build up on information having three aspects; measurable-aspect related to uncertainty in the physical world, 'content'-aspect that is worked out by mind and 'intent'-aspect for interaction with self (**LINK**: Fig. 1). Information is otherwise non-sensible till the content aspect i.e., the 'form' within in*form*ation is brought out by an inside-out phenomenon by mind resulting in split of in*form*ation into its constituents. We have seen what sense organ can appreciate are only `form' (space-time complex) and movement (rhythm). Therefore, unless the form i.e. space-time complex within in*form*ation is revealed, information remains as 'nonsense'. In this context the author has a theoretical construct (Mukhopadhyay, 2008) relating conjugation of information with mind to create space, time and energy; a proposal which requires further in-depth exploration. Whether any information merits reaching the level of consciousness is determined by three factors working at threshold level: *concern*-threshold of self, *intent*-threshold of relevant information and *perfection*-threshold of the decision to be followed. When the intent of information satisfies the concern of self for a desirable degree of perfection as decided for the system, information is granted autonomy. If not, information has to be brought to the conscious level, to be examined by self for its intent. There are still several explanatory gaps. Much expected paradigm shift in the discipline of informatics requires inputs of insights from the result of research (i) on why information generation is prerogative of only living organism, why inanimate object cannot generate any new information (ii) on the difference between silicon-based storage of information in inanimate and carbon-based storage of

information in living organism (iii) on the difference between active and inactive information. (iv) Is life and/or consciousness necessary to make inactive information active? What switches on the operational mechanics of information? (v) How information entanglement differs from quantum entanglement and works as the binding element in unifying consciousness? Not quantum entanglement but information entanglement seems conceptually more proximate to consciousness! With so much available data on informational macromolecules, why are we far away from consciousness?

Consciousness in the Brain

So far the discussion on consciousness is confined to single neuron. The complexity in the brain is much more than what one even can imagine! In the brain, there are 10^{11} neurons and 10^{12} glias. Each neuron communicates with other neurons through 5000-10,000 synapses. Synapses are tri-partite (Araque et al, 1999, Araque and Navarrete, 2010) where astrocyte foot processes actively participate in synaptic channeling. In human cortex, one astrocyte is said to modulate approximately two million synapses (Oberheim et al, 2006). Astrocyte has left its broom and picked up the Beaton in the brain (Panatier et al, 2006). In the brain information-carrying live-hardware is made up of neuron-neuron, neuron-astrocyte, astrocyte-astrocyte and astrocyte-neuron circuitry. Besides, there may be 'wireless' connection between neurons through various classical and quantum fields. Amongst this incomprehensible complexity, the simple message which emerges is that the issue of consciousness in the brain is not an issue of how matter-energy creates consciousness. As living cell, neuron and glia are all conscious in their own respective way. Both neuron and glia exchange matter and energy with the micro-environment of the brain. While there might be debate on whether life originated from matter, there is no doubt that living cell generates matter. The matters in the brain have not generated *de novo*. All visible matter (if not dark matter!) in the brain are products of neurons and/or glia. Therefore, the real issue in the brain is not matter-based origin of consciousness but how individual consciousness of 10^{11} live neurons and 10^{12} live glia is expressed as unitary consciousness in the behavior of the whole brain. If our neurocentric vision of consciousness is true then we are yet to explain properties like neuron-philia of consciousness and consciousness-philia of neurons. Interestingly, we get more insights on consciousness out of renaissance in understanding of neuron-glia partnership than from achievements in systems neuroscience, neurogenomics or regenerative neuromedicine. Some of the footprints of neuron-glia partnership have already been identified in consciousness research. Banaclocha (2007) has pointed out that while steady state (DC) magnetic field is the result of astrocytic network time-varying (AC) magnetic field is the outcome of neuronal network. Astrocytic magnetic field has also been implicated in storage of memory, preservation of content of consciousness. Temporary loss of consciousness in epileptic seizure has been said to be due to disturbance in calcium waves within astrocytes (Halassa et al, 2007). Alfredo Pereira (Jr.) (2007), inspired by the architecture of a large scale ion trap quantum computer (Kielpiniski et al, 2002), proposed a mechanism for consciousness where calcium ions trapped within astrocyte is surrounded by electrical fields of neural circuitry creating a quantum protectorate-like situation. Therefore, the bottom-up enquiry on the issue of consciousness inside the brain is not going to be resolved till we understand more about information in terms of pattern and rhythm of its channeling through live-hardware of neuron and astrocyte, its processing by mind, mind-self interaction through information and phenomenon, information entanglement and overall influence and contribution of 'life' in such operations.

Concluding Remarks

When we analyze the view that consciousness makes the ground and other players like, self, mind, 'life', information are on the foreground, we are to add that the ground-consciousness, unlike any other ground, is a participating ground (LINK: Fig. 1). Consciousness is not merely a 'noun', depicting only an ontological status that leaves an epistemological dead end for science. Consciousness also acts. It has an operational mechanics to integrate numerous autonomic operations which otherwise would go chaotic. Consciousness restricts a situation of divided self. It is incessantly creative as mentioned earlier.

Consciousness, therefore, has an element of verb within it which is manifested as epistemic consciousness. This mobile facet, kinetic pole of consciousness may be called nascent nature, *nature* of all natures, or Mother Nature; this is what constitutes in philosophy the masculine and feminine facet of the absolute ground. In this sense, self is the heir son and life is the daughter darling of consciousness-Mother Nature. When the participation from consciousness irrevocably stops in the system, mind ceases to operate, self becomes functionless and life shrinks to what we call death. The strength of the statement can be verified in unicellular model as well as in a comatose patient under life-support system.

The inextricable connection of consciousness, self, life, mind and information can be understood by analyzing their operations. What makes us seriously handicapped to investigate this domain is another reality where the respective mechanics operates perhaps beyond Planck's scale of nature. This is what compels many of us to see these operations as fictitious. However, there is sunshine in this cloud. Quantum physics initially was also not accepted on a similar ground by the doyens of science, till its classical correspondence was made explicitly available to them. Similarly till the effects of operational mechanics of mind, self, life, consciousness are made observable and measurable in quantum and classical scale of nature and are effectively translated in quantum language and/or in the language of quantum/classical biophysics and molecular biology, we would be far from any solution on the issue of consciousness.

At the end may I remind the reader of the image where a skeleton is seen to examine the skull, the brain is seen to examine another brain or an eye looks at another eyeball! Can consciousness ever examine consciousness itself? In such a recursive situation what best we can do is not to get bogged down with question like what consciousness is but to work on the question like what does consciousness do and make an effort to connect our known mechanics, classical and quantum mechanics with operational mechanics of information, mechanics of Mother Nature and mechanics of consciousness. For the lost self information remains the key thread to reach consciousness en route operation of 'life'.

References

Araque, A., Parpura, V., Sanzgiri, R.P., and Haydon, P.G. (1999). Trends Neurosci. 22, 208-215.

Araque, A., and Navarrete, M. (2010). Philos. Trans. R. Soc. Lond. B. Biol. Sci. 365, 2375-2381.

Banaclocha, M.A. (2007). Brain Res. Bull. 73, 21-27.

Bird, A. (2007). Nature 447, 396-398.

Borrelli, E., Nestler, E.J., Allis, C.D., and Sassone-Corsi, P. (2008). Neuron 60, 961-974.

Bremermann, H.J. (1994). Self organization in Evolution, Immune systems, Economics, Neural Nets, and Brains. In, *On Self-Organization. An Interdisciplinary Search for a Unifying Principle*. Eds. Mishra, R.K., Maaβ, D., Zwierlein, E. Springer-Verlag, Berlin, 5-34.

Chen, W.G., Chang, Q., Lin, Y. , Meissner, A. , West, A. E., Griffith, E.C., Jaenisch, R., and Greenberg, M.E. (2003). Science 302, 885-889.

Day, J.J., and Sweatt, J.D. (2011). Neuron 70 (5), 813-829.

Grinberg-Zylberbaum, J., Delaflor, M., Attie, L., and Goswami, A. (1994). Physics Essays 7(4), 422-428.

Halassa, M.M., Fellin, T., and Haydon, P.G. (2007). Trends. Mol. Med. 13, 54-63.

Kielpinski, D., Monroe, C., and Wineland, D.J. (2002). Nature 417, 709-711.

Meaney, M., and Ferguson-Smith, A.C. (2010). Nature 13 (11), 1313-1318

Mellem, J.E., Brockie, P.J., Madsen, D.M., and Maricq, A.V. (2008). Nat. Neurosci. 11, 865-867.

Mukhopadhyay, A.K. (2008). Frontier Perspectives. 16 (2), 19-29.

Oberheim, N.A., Wang, X., Goldman, S., and Nedergaard, M. (2006). Trends Neurosci. 29, 547-553.

Panatier, A., Theodosis, D.T., Mothet, J.P., Touquet, B., Pollegioni, L., Poulain, D.A., and Oliet, S.H.R. (2006). Cell 125(4), 639-641.

Pereira, A. (Jr.) (2007). Quantum Biosystems 2, 80-92.

Weaver, I.C.G., D'Alessio, A.C., Brown, S.E., Moshe Szyf, I.C.H., Meaney, M.J. (2007). J. Neurosci. 27, 1756-1768.

"As long as a branch of science offers an abundance of problems, so long is it alive; a lack of problems foreshadows extinction or the cessation of independent development."

- David Hilbert in Paris, 8 August 1900