Pluridisciplinary Approaches to Consciousness

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Abstract
This communication was an introduction lecture of our Symposium about Science of Consciousness. We show that a pertinent study of human consciousness should be a pluri-disciplinary approach through Biochemistry, Biology, Biosemiotics, Cybernetics and Artificial Intelligence (A.I.), Language and Logic, Nanochemistry, Neurochemistry, Physics, Psychology. We ask many questions from relevant perspectives to scientific researchers.
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1 Overview of the Scientific Problem of Consciousness

Consciousness is the greatest challenge facing Twenty First Century sciences. The experience of self as a conscious thought creates a self-reflectivity. Yet the very notion of self-reflectivity seems beyond the bounds of analysis. Consequently, the capacity for the synthesis of conscious thought appears to be uniquely connected to individual human development. This uniqueness of the individual capacities appears to emerge from individual experiences in the world and the individual actions, reactions and perceptions. As we age, our individual cumulative histories create conscious capabilities that remain as baffling as the Oracles of Ancient Greece. In a wider frame, cultural historians clearly show that the nature of human consciousness continues to develop in its very depth and breadth as we grope to understand the "other", the community and ourselves. As we move toward an intimately interconnected globalized community, the simple question, "Who is thy brother?" moves from the domain of ancient texts to the pragmaticism of the next business deal.

A principle difficulty in constructing a "Science of Consciousness" is to enfold the material origins of living systems with the realities of human communication. The diversity of postulates on the nature of consciousness often invokes an a priori ideology,

such as a spiritualism [Fritjof Capra, Gary Zukav, Nrusingh Charan Panda] which has been hardly criticized [Leon Lederman, Peter Woit] or a materialism [Jacques Monod] or an evolutionary vision [Teilhard de Chardin]. How can we isolate the credible scientific ideas from the accompanying ideologies? What will become the necessary correspondence principle that binds consciousness to the natural sciences?

A further difficulty in understanding consciousness is that with each advance in neurochemistry and neurophysiology, the cyberneticians invent new automata that mimic the function, re-enforcing the presupposed idea of brain-computer analogy. Yet, the intrinsic nonlinear dynamics of Biosemiotics appears to deny the very possibility of equating 'Shannon bits' to thought. Is this an indication of the unity of science or does it imply that the science of consciousness demands a completely new descriptive language, originating in and paralleling the emergence of life and mind? To what extent can the science of consciousness be forced into existing scientific paradigms? What justifies the use of 'forcing functions' to transform conscious thoughts and feelings into the current language of mathematics and the molecular sciences?

The neurophysiology of the brain is described in terms of interactions between neural and other cells. Electrophysiological recordings describe electromotive potentials of ionic shifts (Hodgins-Huxley equation) and demonstrate the dependencies on over one hundred different organic neurotransmitters. Membrane changes are integral to the transfer of natural information. The number of synapses of the human brain is estimated to be on the order of ten to the 15 th! To what extent must we give up the strong determinism of classical electrodynamics or is it merely a matter of intractable combinatorics?

Since John von Neumann, brain has been compared to a digital computer and this viewpoint has dominated Science until recent times. In this reductionistic model of brain, Man is described as a computing automat (a robot) and authors of such copyrighted publications do demonstrate that themselves are scientific automata. Do they truly think by themselves?

To cancel this objection, Cybernetics has conceived and developed automata with Artificial Intelligence using inference engines and choice algorithms. Moreover Igor Aleksander has used the words "Artificial Consciousness", which explains nothing and does not cancel the above objection.

A neuron is either excited or inhibited like a bit which is valued 0 or 1, but we now know that a neuron is much more complex than an electronic memory bit and that a neural system does not obey a binary logic. This has led to creating neuronal – like computers that work with fuzzy logic.

Brain models presently fail to work like quantum computers, as Q-bits actually require cold-mirrored cavities to work properly. Stephen Gislason along with electronic engineers think that brain should be viewed as an analog computer not digital.

In other ways, some electromagnetic theories of consciousness [John Joe McFadden, E. Roy John] which has been criticized [Susan Pocket], a holonomic brain theory [Karl Pribram] and a theory of emergence processes up to consciousness [A.C. Ehresmann & J.P. Vanbremeersch] have been proposed.

In the initial quantum theory, the observer's consciousness was considered as being inseparable from the quantum system in which his measurement is performed [J. von Neumann, N. Wiener, J.B.S. Haldane] as the quantum collapse was proposed to be related to the particular observation. So, considering consciousness as a quantum observable (through any measurement) they thought to introduce a second observer B who observes the observer A. This leads to a methodological paradox where Consciousness belongs to both the observed "object" and the observers A and B themselves.

The problem of observers' consciousness has been turned out by automating quantum experiments with automatic recording of data and computer treatment of experimental results. However in most experiments related to consciousness, the true studied object is not consciousness but just information transfer (e.g. reaction to stimuli) within a communication between two observers.

Now some physicists have claimed that it is required to introduce quantum theory in new brain models, while a theory of quantum computers is being developed and prototypes of Q-Bits memory are being tested.

It has been suggested that quantum superpositions and quantum correlations may take place in microtubules (MT) inside neurons, in alpha-beta tubulins, in some proteins (MAPs) associated with microtubules [Ezio M. Insinna]. As all eukaryotic cells have cytoskeleton with microtubules, their activities might be supposed to have their own awareness and to participate to the Central Consciousness. At the scale of neuron microtubules, a nanochemistry might be required to understand the properties of Ca2+ ion through MT lattice, the hydrolysis of GTP molecules of alpha, beta tubulins monomers and dimers, etc.

Since H. Fröhlich who introduced the concept of "cooperative vibrational modes" between proteins, the coherent image in mind comes from electric oscillations and resonance (in 1010 to 1012 Hz) of brain neurons between electric dipoles in proteins involving cell membranes. From this viewpoint, is a non-linear electrodynamics required? [S. Hameroff].

As there is no possible freedom of thinking in classical brain models, at least a few conscious thought should be non-computable, as it can be deduced from Gödel's incompleteness theorem and from the mathematical axiom of choice. To obtain non-computable quantum states in MT, Roger Penrose has introduced a new type of quantum collapse: the "Objective reduction" (OR) that requires a threshold related to a form of quantum gravity [S. Hameroff]. This self-collapse introduces non-computability that is "an essential feature that distinguishes our minds from classical computers".

After John Eccles, Roger Penrose's works has considered consciousness as a quantum non-local process in neuron microtubules and this has led to think that Consciousness is a dimension of Reality in itself, as Space-Time is. Some space-time theories of consciousness have been conjectured [Alex Green, Elizabeth Rauscher].

2 A Pluri-disciplinary Approach to Consciousness

The whole nervous system is concerned with consciousness, but in many publications, only the brain is specifically considered. It is often considered that a perception become conscious to the perceiver only in some neurons in brain, but the evidence for this is sparse. Consciousness may involve many processes, including:

- neuro-anatomical mechanisms,
- thalamus and cortex functions,
- neurotransmitters and biochemical dynamics,
- anesthetic effects erasing consciousness,
- chemical transport across neuron membranes,
- electrical activities of neurons (with oscillations and resonance),
- electrical properties as well as coding properties of DNA,
- temporal sequences of activation of brain areas,
- etc ...,

The study of human consciousness should lead to a pluri-disciplinary approach:

- collating facts about conscious experiences,
- study of the waking-sleeping cycles vs. biological parameters,
- cognitive functions, visual perception and "altered states" of consciousness,
- the structure of natural languages vs. neural physiology,
- individual will, willfulness, and domination,
- extension of biological evolution to the evolution of consciousness,
- the emergence of self-consciousness: the awareness of "Me".

3 Questions from Relevant Perspectives

3.1 What is consciousness ?

Can we define the bounds of the concept of consciousness ?

Is consciousness only a perceiving system, a system of awareness ?

Where does the action of will take place in a biological system ?

Have the modern neurosciences resolved the syntactical problems of consciousness, thereby reducing it to merely a semantic problem ?

3.2 Brain Areas and Consciousness

How can a brain produce a unique consciousness state ?

During sensory perceptions several different brain areas are activated. From the retina, information is stored in several brain areas: one for movements, one for colors, one for colored forms, and one for moving forms.

Is there a possible location of Central Consciousness in brain ?

How are separated brain areas connected together into a general state of consciousness ?

3.3 Neurons and Consciousness

Does self-consciousness take place in a specific anatomical region (neocortex) ?

Are there specific neurons and specific proteins that have the required property to be locations of central consciousness ?

How are data processed in temporal sequences of activation of brain areas ?

If we must speak of a "distributed consciousness", in what sense is the distribution a part-whole relation ?

3.4 Genetic Code and Consciousness

How does DNA, as the chemical code for life, serve as a generating function for the development of consciousness ?

How does DNA introduce limiting factors in the consciousness of individuals ?

Do advanced states of consciousness demand specific states of gene support ?

In what sense is the natural information of consciousness related to formal Shannon information ?

3.5 Artificial Intelligence and Consciousness

Can consciousness be inverted into or emerge from the notions of "Artificial Intelligence" ?

Can a semantic level exist in constructed software that is embedded into a computational machine ?

Are all conscious thoughts resulting from computable processes ?

Is there any freedom of thought implemented in an A.I. robot ?

Must we consider that some conscious thoughts are non-computable processes, as a consequence of Godel's incompleteness theorem ?

3.6 Neuronal Microtubules and Consciousness

Can the processes in neuronal microtubules be explained fully within biochemical theory ?

Can processes in neuron microtubules be explained with nanochemistry ?

Do neuron microtubules contain something like Q-bits with their own error correction mechanism ?

Do neuronal microtubules involve non-computable quantum processes ?

Will nanotechnology enable us to build robotic machines involving a real consciousness ?

Self-Consciousness, Anticipation, Neocortex, Immune System and DNA

Are "I", "Me" just words in human languages ?

Is the Ego a psychological expression of self-consciousness ?

Where does the consciousness of "Me" biologically originate from ?

Has Man an image of himself in his biological system, and so has he an anticipation capability ?

Has every animal species an image of himself in his biological system ?

Is self-consciousness elaborated in the neocortex ?

How is self-consciousness due to the self-recognition exhibited by the immune system ?

Does self-consciousness emerge from communications between cells, that is, messages rather than structures ?

Is self-consciousness to be intimately related to physical properties of DNA ?

Can the motions of prokaryotes and simple eukaryotes be said to be simpler form of consciousness ?

3.7 Emergence of a General State of Consciousness

At what levels of organization does consciousness take place ?

Can Central Consciousness be derived from a coherent quantum state in synaptic gaps ?

Or from a coherent quantum state in neuron microtubules ?

Or in microtubules of all cell cytoskeletons ?

How is it actually explained by the concept of a holographic brain ?

Can Central Consciousness be derived from electric resonance and coherent oscillations within proteins ?

Does it involve DNA properties and gene mutatability or plasticity ?

Is Consciousness a specific dimension of Reality beyond Space-Time?

In what sense can we speak of the consciousness of a group ?

In what sense can we speak of a cultural consciousness ?

3.8 Possible Emergence of a Superior State of Consciousness

Are there biological explanations of Near Death Experiences (NDE) ?

What can be said of the so-called "altered states" of consciousness ?

Can we talk of enhanced holographic levels of non-local states of consciousness ?

4 Conclusion

Most questions about consciousness and self-consciousness are partly answered by every science, as the fundamental questions will remain opened to future pluridisciplinary studies.

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