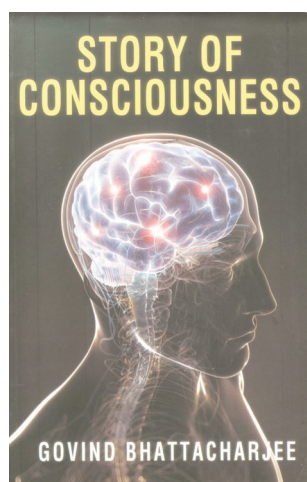


Th17, Tregs and Th2 cells respectively, in the gut. Several bacteria-sourced products can either drive pathogenesis or help to alleviate symptoms of Crohn's disease and ulcerative colitis. Faecal microbiota transplants from healthy individual to patients of ulcerative colitis, Crohn's disease, and multiple sclerosis have met with some success. Greater elucidation of the role of particular microbiota products play in disease onset or amelioration will give rise to more defined therapeutics for auto-inflammatory and autoimmune conditions.

RUCHI SACHDEVA
MOUMITA SARKAR
RAHUL PAL*

*Immunoendocrinology Lab,
National Institute of Immunology,
New Delhi 110 067, India
e-mail: rahul@nii.ac.in



Story of Consciousness. Govind Bhattacharjee. Vigyan Prasar, Department of Science and Technology, A-50, Institutional Area, Sector-62, Noida 201 309, UP. 2019. xii + 372 pages. Price: Rs 450.

Bhattacharjee tried to narrate a story of something (called consciousness) which itself is a debated and little understood to the scientific community. He depicted the evolution of consciousness. In fact, the term consciousness has been mostly discussed and debated among the philosophers from the East as well as the West antiquity. The progress of modern science especially in neuroscience and

quantum theory raises new interest among the community. At first, we need to discuss 'what is consciousness'. The prerequisite for this discussion needs a comprehensive analysis of the methodology used in different knowledge systems, i.e. in science as well as in philosophy.

Various schools of Indian philosophy (including Buddhist one) discussed extensively this issue. Vedanta and Advaita Saivagam of Kashmir both made a comprehensive study on ultimate reality, nature of reality and consciousness.

The progress in neuroscience as well as in modern physics especially the birth of quantum theory raises interest about the nature of reality and its connection with consciousness. The motive of both philosophers and scientists is to understand the ultimate reality, though with different perspectives but arguably the same purpose to move closer in knowing the truth. Let us first discuss the methodology used in science. The approach called 'Empiricism' which over a period of time has become the standard and accepted method of science whereas the (ancient Indian) philosophers adopted a method called 'Introspection' thousand of years ago – sit and meditate after registering in memory all the information gathered by their senses and processed by their mind after consultation and discussion with their peers and absorbing the esoteric inputs from the scriptures. The methodologies are quite different – scientists constructed the theories mainly based on empirical data and adopted the approach known as reductionism. On the other hand, the ancient Indian philosophers used the data mainly based on introspection and also reasoning.

For example, scientists try to understand the macroscopic world (consisting of everyday objects) from microscopic world consisting of elementary entities like electron, proton, quarks, Higgs boson, etc. The birth of quantum theory in early twentieth century clearly shows that quantum theory is needed to explain the behaviour of microscopic entities which is different from Newtonian mechanics used in explaining the behaviour of the objects in the macroscopic world. Since the physical universe is ultimately composed of these elementary entities, it gives rise to the much-debated issue whether the universe itself is governed by quantum theory. This is related to nature of reality at various levels, i.e. at microscopic scale and macroscopic scale.

The scientists follow the deductive approach to understand the nature of reality.

Now to unravel the mystery of consciousness the scientists follow this reductionist approach. The pertinent issue to a scientist in understanding consciousness is: from where to start. In the laboratory, the scientists start with microscopic entities and their interactions to understand the various aspects of everyday world (macroscopic world). In the context of consciousness, the obvious approach is to start from billions of neurons or nerve cells in human brain (consists of 10^{12} neurons) because our thoughts, perception, etc. arise from neuronal firing due to the stimulus from the external world through our sensory organs. Looking at given stimuli results in neural sensations; a mental concept of the given stimuli results from comparisons of sensations; interpreting the thus formed mental concept (of the given stimuli) into consciousness (background) results in perception (of the stimuli).

However, there exists huge gap in understanding the correlation between thought and the neuronal firing. It is important to note that brain not only process information but also interpret it as emphasized by Karl Pribram. Scientists like Edelman, Tononi and others applied information theory in brain function and consciousness issue. We emphasize that one should look for a information measure with semantic aspect to understand the information processing in the brain as well as understanding consciousness. It is worth mentioning that so far the author knowledge goes no such information theory exists in science and technology where semantic aspect is included in the formulation. The discussions on this aspect of information might enrich the book (*Story of Consciousness*) though the works of Edelman, Tononi, etc. are discussed by the author in some other context.

The scientists are trying to understand consciousness as epiphenomena which emerge from the activities of billions of neurons in the brain. For this they are trying to identify the neuronal circuitry and neuronal dynamics based on the laws of physics. Neuroscientists are working on the functional states of neurons and consciousness. Rodolfo Llinás proposed that consciousness seems to result in some manner from an interaction between the thalamo-cortical scanning activity and the incoming stimuli from the

environment. The role of memory and the underlying mechanism of consciousness become one of the fascinating areas of research in modern neuroscience. The important observation of Llinas is useful and raises fundamental issues:

‘The role of the memory is very important but... not as important as we believe. Most of the important things that we do don’t depend on memory. To hear, to see, to touch, to feel happiness and pain; these are functions which are independent of memory; it is an *a priori* thing. Thus, for me, what memory does is to modify that *a priori* thing, and this it does in a very profound way. But we cannot learn how not to recognize the differences between green and red. What we can learn is to change its sensibility (for example, that orange color is too red to paint an orange fruit) or its meaning (red, stop; green, proceed).’

The most challenging question in understanding consciousness from neuroscientific perspective is to understand ‘subjectivity or subjective element’ within the current paradigm of scientific research. The subjective element for example, ‘qualia’ like redness of flower – can it be explained by the laws of physics? If not, we need new paradigm to understand consciousness. The author did lot of efforts making a long list of references. It would have been better if the references of Karl Pribram and Rodolfo Llinas be added there.

Another intriguing issue is whether a single cell, say a single neuron is conscious? Then one should understand what happened in case of ensemble of

neurons? Works are going on and we do not have any answer for this.

This review will be unfinished unless I mention the investigations on the possible role of consciousness in quantum theory. Great minds like Wigner, Pauli, Penrose, Hameroff, etc. discussed the role of consciousness in resolving the measurement problem in quantum theory. The birth of quantum theory raises lot of discussions on the role of observer in understanding the reality in the physical world. But the issue is how to incorporate the role of consciousness or its subjective element in resolving the measurement problem. Attempts have been made by scientists to explain the reduction of wave packet in quantum theory considering the role of psyche or mind or subjective element.

Dean Radin performed the famous double slit experiment where he claimed that the attention or constant observation by Human observer reduces the interference term. But this experiment is not repeated in any other laboratory. Its claim is yet to be justified. In another attempt Penrose and Hameroff claimed that reduction of the wave packet associated with external stimulus occurs in the brain because of the gravitational field due to space time curvature associated with microtubules. This approach has been severely criticized by many researchers in this field. In some other attempts, scientists (Uemzawa, Vitiello *et al.*) used quantum field theory to understand the memory and consciousness. But we emphasize that there is a fundamental issue which must be resolved before applying any variant of quantum theory (for example, Hilbert space formalism by Pribram, Jibu and Yasue) or QFT in

understanding brain function and consciousness.

The central issue in brain function is the internalization of the properties of the external world into an internal functional space. By internalization, we mean the ability of the nervous system to fracture external reality into sets of sensory messages and to simulate such reality in brain reference frames. The issue is whether brain cognizes space time which we use for the description of external world. Two outstanding neuroscientists Llinas and Buzsaki recently showed that with the present understanding of anatomy of the brain it is not possible to show how the brain cognizes the space time what we use in physical theory. Unless the issue is resolved it is very difficult to think of applying any variant of quantum theory in brain function and consciousness.

Lastly, I am tempted to mention an insightful remark by Llinas that people spent many years to understand the mechanism of the flying of the birds by studying the anatomy of bird’s brain. But as soon as the principle of buoyancy is discovered, one does not need to understand the anatomy of bird’s brain to understand the flight of the birds. It may happen something similar to consciousness – discovery of a very simple physical principle will unravel the mystery of consciousness and the story of consciousness has to be rewritten.

SISIR ROY

*National Institute of Advanced Studies,
Indian Institute of Science Campus,
Bengaluru 560 012, India
e-mail: sisir.sisirroy@gmail.com*