

# Introduction to the Special Issue on Biological Mentality

## Guest Editor

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## Abstract

The Workshop on Biological Mentality took place on August 7-8, 2017 in Ann Arbor, Michigan. The term biological mentality encompasses the presumably non-conscious capabilities of our biological ancestors as well as our own non-conscious and conscious mentality. Biological mentality requires a physical foundation, one that perhaps transcends the computer metaphor. This Special Issue describes much of what was covered in the workshop. A second workshop is scheduled for September 24-26, 2018.

The papers presented here stem from a Workshop on Biological Mentality that took place on August 7-8, 2017. The Workshop was sanctioned by Michigan Technological University and held at the MTRI conference facility in Ann Arbor, Michigan.

As the workshop organizer, I chose the term *biological mentality* for the title of the workshop. I wanted to back away from trying to find a direct link between human consciousness and physical processes such as quantum measurement. In the history of the Earth, life appeared quickly relative and evolved relatively slowly. Perhaps the key to discovering the physical foundations of consciousness might be to first work out the physical foundations of *non-conscious*<sup>1</sup> mentality, including both the mentality of

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<sup>1</sup> Also known as *unconscious*, *subconscious*, etc.

primitive organisms that presumably lack consciousness as well as the mentality more advanced organisms that do possess consciousness. Perhaps if consciousness requires a quantum explanation then the non-conscious does too. And if consciousness transcends Turing computing then perhaps our earliest evolutionary ancestors found a way to do this transcending long before consciousness emerged.

I invited people to participate in the workshop whose works I admired and who did not necessarily agree with my views on these matters.

Several weeks before the Workshop, I sent the following guidance to all of the participants:

1. Please try to explain your ideas in simple language. You are not presenting to your technical peers but to an audience with a wide variety of different backgrounds.

2. Please don't worry about *defending* your ideas. You can do that at specialized academic conferences and in peer-reviewed journal articles. Here we just want everyone to understand what your ideas *are*.

3. Don't worry too much about *consciousness*. Biological mentality is evident in primitive organisms whether they are conscious or not (who knows?). Of course if you have specific *ideas* about consciousness, fine, we would love to hear them. But we are also interested in mentality that is not conscious, including our own non-conscious thinking.

4. Please feel free to go out on a limb and give us your far-out thoughts, including if appropriate your thoughts on:

- a. Is our understanding of the brain unduly constrained by the computer metaphor? Is data processing sufficient to explain the mentality of living organisms? Is a living organism essentially the same as a computer-controlled robot or is there something more?

- b. Are quantum coherent processes present throughout the brain and if so how might they relate to mentality?

- c. Might the phenomenon of life be informing us that something new in physics is needed? And if so, in what new direction might physics go?

The initial Program for the Workshop can be found at <https://sites.google.com/view/mtu-cplo/>. Also at this site you will find a pre-workshop quote from each participant, a link to one of their recent papers that I admired (click on the participant's name), and the slides they used in their

workshop presentation. This initial Program was modified somewhat as the Workshop progressed. Not shown on the Program are presentations made by Chanelle Jumper and, later, Ted Goodson and Steve Lehar. Slides from the presentations of Adrian Kent, Ted Goodson, and Steve Lehar are not available.

In this Special Edition of the Journal of Cognitive Science we offer new papers from some of our Workshop participants, papers expressing thoughts that may have evolved somewhat from their Workshop presentations.

I would like to acknowledge the great help in planning and conducting the Workshop provided by Michelle Wienert and others at MTRI, the support for the Workshop provided by David Reed, Vice President of Research, Michigan Technological University, and the encouragement by Ravi Pandey, Chairman of the Michigan Tech Physics Department. Special thanks to John Myers of Harvard University who helped me in ways too numerous to mention. Special thanks also to Chungmin Lee, Editor-in-Chief, Journal of Cognitive Science, for his help and encouragement.

The following are post-workshop quotes from some of the participants in the Workshop of Biological Mentality.

By a kind of cognitive recursion we can try to physically describe the tight relation between the architecture of the experiencing agent with the phenomenon of conscious experience. The most convincing physical connection between the information based structure of the brain and the primitives of experience resides in specific electron de-localizations at the quantum scale within ion conducting membrane proteins of electrically excitable cell membranes. There is a basic dualism between subject and object which is physical on both sides and realized by an inversion relation along one-sided surfaces. The transition between these two aspects however is non-physical and hosts the phenomenology that characterizes subjectivity. Together with an increasing number of studies on the electron transport within peptides and possible Chiral Induced Spin Selectivity effects along alpha-helices, I find that electronic transfers in the filter linings follow a bridge mediated electron transfer on a distinct atomic topology. This

topology looks like a non-orientable surface (Möbius-band) and offers a spin-selective inversion transformation.

- Gustav Bernroider

Without admitting any explicit notion of an agent, quantum theory implies a role for an unpredictable symbol-handling agent. To accept agents and symbols into physics is to see mechanisms, especially clocks, not in isolation but as tools that agents build and adjust as needed. Logically synchronized rhythms of symbols need not be seen as taking place in some externally supplied “space and time,” but instead are the raw material out of which physicists construct time, space, and spacetime. We hypothesize that all living organisms employ logically synchronized rhythms of symbols.

- John Myers

There is a risk that physicists succumb to a form of learned (in both senses of the term) helplessness when confronted by a literature in which every plausible argument is opposed by plausible counterarguments and every interesting position has potentially insurmountable difficulties. Intellectual paralysis is not inevitable in such a situation. It may be that our framing of the problem is conceptually inadequate, and that physics could ultimately help reframe it if we looked in the right directions. In particular, current developments in the foundations of physics could suggest possible ways of acquiring new empirical evidence about the relationship between physics and consciousness, and the status of existing arguments might look different in the light of such evidence.

- Adrian Kent

When we say that we understand a system, we are supposed to know the operating principle, and can control the system. If we assume that consciousness emerges from the brain, and we want to understand the physical foundation of consciousness, we need to figure out the operating principle of the brain, from which

consciousness emerges in the brain, and we should be able to control consciousness by modulating the brain, then, we could say we understand the physical foundation of consciousness.

How can we safely control consciousness in the human brain? First, we can separate consciousness into the level and quality of consciousness, and control the level of consciousness, rather than the quality of consciousness, which is more difficult to handle. The most reliable and safe method to control the level of consciousness in the human brain is anesthesia, which has been using for about 40 million patients per year only in US. Our interdisciplinary research team from physics, neuroscience, and medicine has been compared the brains under the conscious and unconscious states to identify neural correlates of consciousness. Especially, we are now interesting in identifying the physical principle of state transition between conscious and unconscious states, mainly focusing on the critical moment at which unconscious state transitions into conscious state. Network synchronization and nonlinear dynamics are used to identify the physics of state transition that explains how disintegrated brain network converts into integrated brain network. We expected that identifying the exact moment of state transition in the brain and the physical principles for generating abundant and ceaseless information and dynamic integration and disintegration may play an important role in understanding the physical basis for the emergence of consciousness from a system.

Furthermore, we are now trying to control rodent's consciousness by modulating the integration capacity of the brain with pharmacological and electrical stimulations. We expect that if we could control consciousness fully in the rodent brain in a principled way, that is, converting unconscious state to conscious state or vice versa, it will lead us to understand the physical foundation of consciousness in the brain. And it will also provide a theoretic basis to study more higher level of consciousness (i.e., qualia) such as the awareness of self and the world as the next step.

- UnCheol Lee

If quantum processes occur in the brain, where might they take place, and how are they generated? In regards to the “how”, the aerobic life process results in the release of energy in the form of very weak light spanning the ultraviolet, visible and infrared parts of the spectrum. While typically considered as waste energy, life may have evolved to utilize such emissions to serve as information carriers. Light particles are well suited for transmitting quantum level information over considerable distances. Evidence is mounting that living systems, in the form of plants and bacteria, are capable of withstanding, and even utilizing, biology's “warm, wet, and noisy” environment to support such quantum phenomena, therefore it is not unreasonable to suggest that such a process may also take place in the brain, and may have bearing on brain function. Now, how does this generate subjective conscious experience? That's the hard part.

- Travis Craddock

Although the behavior of agents does not contradict to physical laws and models, it cannot be explained by physics alone. The notion of agency is essentially non-physical; it refers to the capacity of agents to perform various functions in a set of possible environments in order to achieve such goals as eating, digesting, moving, sensing, hiding, smelling, and reproducing. Obviously, *functions and goals* do not belong to the vocabulary of physics. Physics is interested mostly in changes restricted by natural laws that are best seen in either closed systems or systems with steady boundary conditions. In contrast, the main component of agent behavior is in the overcoming of physical constraints by exploiting variations in boundary conditions: agents selectively interact with external components and use them to achieve their goals.

Thus, the gap between the physical world and agency (both in time and space) becomes filled with agents of progressively higher agential capacities. This approach, on one hand, eliminates binary dualism between agents and physical world, and on the other hand, does not allow reduction of agential capacities to the function of

subagents (because subagents have lower agential capacities). Agents have a different ontological status than physical objects because they do not just exist, but exist for their internal purpose. In particular, they are produced by parental agents for the purpose of preserving functional identity within the lineage and offering chances for future expansion and optimization of agential competence.

- Alexei Sharov

We do not know what consciousness IS. However, it may be associated with quantum measurement. This hypothesis is testable by doing a “genetics of consciousness”. Fruit flies can be anesthetized by ether. Select a subpopulation of flies that is anesthetized by little or no ether. Sequence the genomes of these selected flies and those of the initial “wild type” population. Suppose the selected population has mutant proteins, or RNA. Study where in the fly these proteins or RNA and their wild type analogues are located. Perhaps they are located in synapses, perhaps in the legs or elsewhere. Suppose these mutant proteins are located in the brain. Ask if the wild type protein carries out a quantum behavior not done by the mutant proteins. Since the selected flies are less conscious than the wild type flies, this quantum behavior may be associated with consciousness. As a further test, use second site revertants of the mutant protein via mutations at other sites in the protein, then show that the mutant revertant protein introduced into the selected flies, restores both the quantum behavior and consciousness, including restored lower sensitivity to ether anesthetization.

- Stuart Kauffman

Functionalism is the view that the mind is the functional organization of the brain. The Computational Theory of Mind (CTM) is the view that the whole mind—not only cognition but consciousness as well—has a computational explanation. When combined with the empirical discovery that the brain is the organ of the mind, CTM entails that the functional organization of the

brain is computational. Computational functionalism is the conjunction of the two: the mind is the computational organization of the brain. Contrary to a common assumption, functionalism entails neither CTM nor computational functionalism. This finding makes room for an underexplored possibility: that consciousness be (at least partly) due to the functional organization of the brain without being computational in nature. This is a non-computational version of functionalism.

- Gualtiero Piccinini

We all agree that there is such a thing as consciousness but do not agree on either its definition or even whether or not it belongs in the natural sciences. My own approach to this issue is to try and understand what is special about the human brain and the intricate organizational structures within it. I assume that the brain is the seat of the mind (substrate for consciousness) and that consciousness is an emergent phenomenon predicated on the structure of the brain. However, what I do not know, or even assume, is whether or not human consciousness is a quantum phenomenon. Moreover, I see a large “elephant in the room” that is not talked about in this context, namely how life is a necessary precondition for consciousness and how the same structure (brain) can generate consciousness or not depending on whether it is alive or not. This important connection is a *sine qua non* for future research in this area.

- Jack Tuszynski

I suggest an approach to a coherent theory of physics and mathematics together. The effects of local mathematics and the distinction between number and number value on science are noted. The relation between conscious observers, local mathematics, and number value or meaning is emphasized. This work was stimulated by Wigner's famous paper, “On the unreasonable effectiveness of mathematics in the natural sciences”.

- Paul Benioff

In pursuing far-reaching questions in science, such as the nature of consciousness, we frequently stumble upon the limiting assumption that life is transpiring in a so-called ‘warm, wet and noisy’ environment. Effort is immediately put into a discussion about how such phenomena may be possible according to the proposed mechanisms, under such conditions. In reality, we know little about the physicochemical properties of the biological environment, which, being generally heterogeneous, confined, compartmentalized and/or crowded, cannot be adequately described by single value macroscopic parameters, such as those envisioning a statistical heat bath. I propose that alongside investigations of difficult questions regarding the nature of life, we take a critical approach to the physical descriptions of biological matter in terms of system-environment interactions. In our previous paper *Life--warm, wet and noisy?: Comment on “Consciousness in the universe: a review of the ‘Orch OR’ theory” by Hameroff and Penrose*, we question whether we should accept the premise that living entities are founded on uncorrelated and chaotic machinery.

- Channel Jumper