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# Special Issue on the Third Workshop on Biological Mentality

Kenneth A. Augustyn
*Michigan Technological University*, kaaugust@mtu.edu

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Kenneth A. Augustyn

*Department of Physics*
*Michigan Technological University, Houghton Michigan, 49931 USA*
kaaugust@mtu.edu

## Abstract

The Third Workshop on Biological Mentality was held from September 23, 2019 to March 2, 2020 as a series of twenty-one Monday online conferencing sessions, each consisting of a talk followed by a Q&A discussion. Like the two previous workshops [1, 2], the objective of this workshop was to seek a deeper level of understanding the physical foundations of biological mentality (whether conscious or nonconscious).

**Keywords:** *Biological mentality, Mind-matter, Consciousness*

## 1. Introduction

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 robot with artificial intelligence, or is there something more? Are quantum coherent processes present throughout the brain and if so how do they relate to mentality?

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These are some of the questions the workshop addressed in talks and discussions across the boundaries of many different disciplines with the goal of Improving our understanding of biological mentality.

This paper contains the Program for the workshop and brief statements by some of the speakers.

Also in this Special Issue are papers from workshop participants Asim Islam, Alin Cucu, Stuart Kauffman, and Kenneth Augustyn. The previous issue, J. Cog. Sci. 21:2, contained a paper from participants John Myers and F. Hadi Madjid.

## 2. Program

| Date | Speaker | Title |
|---|---|---|
| 9/23/2019 | Alin Cucu | "Energy Conservation, Physicalism and the Prospects for Interactionist Dualism" |
| 9/30/2019 | Kenneth Augustyn | "Life Transcended Computing before the Emergence of Consciousness" |
| 10/7/2019 | John Myers | "Word Sequencing" |
| 10/14/2019 | J. Brian Pitts | "Conservation Laws and the Philosophy of Mind" |
| 10/21/2019 | Gustav Bernroider | "Bright and Dark Physics: A Dual Aspect Physicalistic Interpretation of Biological Mentality" |
| 10/28/2019 | Kenneth Augustyn | "Why the Whole Idea of "Passing the Turing Test" is Damaging Western Civilization" |
| 11/4/2019 | J. Brian Pitts | "General Relativity, Energy Conservation, and Mental Causation: Carroll's Foundling" |
| 11/11/2019 | Brian Josephson | "Towards a New Scientific Paradigm" |
| 11/18/2019 | Robert Prentner | "Where is the Mentality in Biological Mentality?" |
| 11/25/2019 | Marcus Appleby | "Quantum Mechanics and the Problem of Consciousness" |
| 12/2/2019 | Kenneth Augustyn | "Why I like Penrose and Hameroff but don't like Orch OR" |

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|---|---|---|
| 12/9/2019 | Alin Cucu | "Does QM Help Model Dualistic Mental Interaction?" |
| 1/6/2020 | Andrew F. Knight | "Why Mind Uploading, Brain Copying, and Conscious Computers are Impossible" |
| 1/13/2020 | Art Hobson | "The Entangled Measurement State is not a Paradoxical Superposition of the Detector" |
| 1/20/2020 | Robert Prentner | "Phenomenal and Psychological Concepts of Consciousness" |
| 1/27/2020 | Ted Goodson | "Entangled Photon Absorption Applications in Biology" |
| 2/3/2020 | Gustav Bernroider | "Cause and Effect in Biology, Causality in Physics and the Problem of Consciousness" |
| 2/10/2020 | Jack Tuszynski | "Computational Capabilities and Limitations of the Human Brain based on Microtubule Involvement at a Sub Neuronal Level" |
| 2/17/2020 | Asim Islam | "Many-body Quantum Field Models for Nonlinear Brain Dynamics" |
| 2/24/2020 | Stuart Kauffman | "Mind and Quantum Actualization" |
| 3/2/2020 | Brian Josephson | "The Subtleties of Coordination" |

**Statements of Speaker Interests**

**Marcus Appleby**

In physics it is well-known that finding the right question is often at least 50% of the difficulty. In my contribution I did not propose a solution to the problem of consciousness, not even a tentative one. Rather I examined the question. This is in the belief that the question is currently mis-posed. The current conception of consciousness may be regarded as an attenuated version of the Cartesian concept of mind. I argued that the Cartesian philosophy was originally motivated by conceptual problems with Galilean physics. Quantum mechanics changes things. This is not to say that the problem of consciousness is a pseudo-problem, as is sometimes suggested. It is, however, to say that the problem is not quite as is often assumed. In

particular, it is argued that current conceptions encourage an unbalanced conception of mentality, according to which the state of being barely awake is the essence of what it is to be human, whereas the thought processes which led Einstein to the general theory of relativity are something a zombie could manage.

**Kenneth Augustyn**

What we call *the mind* began as a non-conscious robotic biochemical process control system in the very earliest forms of life. As life evolved, problems in control became more difficult and exceeded the computational capabilities of the organisms. Nature discovered a means of transcending computable physical processes giving rise to non-physical mental capabilities that, while still not conscious, were no longer entirely physical. Biological mentality began to have a degree of genuine autonomy from the physical world, affecting the course of (but not the mechanism of) evolution. The integrated amalgam of robotic and transrobotic unconscious capabilities eventually gave rise to consciousness, which became an even more important factor in the course of evolution.

The processes responsible for transrobotic mentality are conjectured to leave evidence in the physical world in the form of violations of conservation laws, evidence that future experiments may be able to detect.

**Gustav Bernroider**

**Bright and Dark Physics:**
**A Dual Aspect Physicalistic Interpretation of Biological Mentality**

Sentience is part of every living organism. It is at the root of life and at the root of an object knowing, conscious subject. It seems that if 'sentience', as the ability to 'feel something', is stripped of its cognitive part, taking

away the (physical) organisation behind it, something very fundamental still remains. We can probably agree to name this something the 'qualia' of sentience. I suggest that the phenomenon of life is identical to the 'qualia' of sentience, i.e. that these two concepts are not just simply related to each other, but are actually the same. Now the question arises how does physics relate to this?

I think it makes sense to interpret physics as a descriptor for the properties of nature that a sentient agent can capture. However, the properties themselves seem to come up in two strictly opposing versions, a duality originating from the same source, reminiscent to the traditional mind-matter duality or subject/object dichotomy. Along this view a Russelian interpretation, perhaps a version as suggested more recently by Jiri Benowski within a 'Dual Aspect Monism' [1] is close to the present conjecture. The difference to Benowskis proposal as I am arguing here is, that the dualities building on one monistic ('Agency') source are not seen in the tradition of Mind-Body dualism, but instead can both be situated within an extended version of physics, a new kind of physics, compatible with the properties of 'closure' but indicating a lack of completeness behind its canonical version. I call the two opposing concepts in physics 'bright' and 'dark'. The terms are purposely suggestive for the increasing demands expressed by 'bright physics' to resolve open questions by referring to some physical 'dark side' (as 'dark matter' or 'dark energy'). This applies particularly to physical situations instantiated at the far ends of scales, i.e. to the low scale quantum level and to the large scale astrophysical level [2,3].

Here I focus on the nature of a relation between the suggested opposing sides of physics as they emerge from one source of 'agency' or 'qualia' in the above sense. Using tools from algebraic geometry, I am arguing that the most radical relation between these dual aspects in physics is provided by a sense relation or mirror symmetry. I provide examples from basic symmetry relations and conservation laws in physics and eventually demonstrate

unique sense-based organizations in biology, e.g. homo-chirality, developmental neuro-psychology and biological chemistries. Furthermore, it seems that these concepts extend into the cognitive-mathematical domain where mirror symmetries precipitate into a basic distinction between what is called 'symplectic geometry' on one side and complex geometry on the other. These latter observations lead us into a question at the root of idealism, about the source of cognitive concepts. In the line of this enduring conundrum it is difficult to suggest a plausible route, but I do find many similarities between the formal structure of cognitive concepts and the structure of geometrical dynamics in our own brain organization. These similarities lead me to assume that the way we think is tightly bound to the way we are organized [5].

Taken together, the present concept shares many aspects with Augustyn's view on biological mentality [4], except one point. I do not consider the most primitive forms of life, as for example apparent in prokaryotic cells, as purely 'robotic'. All life forms within the present view are 'trans-robotic' in Augustyn's sense, carrying the seeds of sentience, with or without consciousness. However, the building up principle underlying 'biological mentality' as suggested in [4] shares many aspects with the view I am proposing here. Perhaps, following and modifying Maturana's and Varela's enactivistic principle [6], a sense relation between a subject and its environment could serve as the organizational principle leading to a higher cognitive (conscious) status of biological sentience.

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[2] Perlmutter et al, Astrophysical J. 517, 565-568 (1999)

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[6] Varela, F. (1984) In Ulrich, H., and Probst, G. (eds.), Self Organization and the Management of Social Systems, Springer, Frankfurt.

**Alin Christoph Cucu**

Quantum mechanics (QM) has long been thought to be able to contribute to the question how consciousness (construed non-physically) can be causally efficacious in the physical world (interactive dualism). One idea is that if non-physical mind interacts on the level of quantum processes, it can bring about macroscopic changes without violating the principles of momentum and energy conservation. However, energy and momentum non-conservation is something physics can deal with (Cucu & Pitts 2019). There is thus no impending clash with any law of nature that QM could help avoid. But even if there were such a tension, QM would be no remedy, since any collapse interpretation of QM entails momentum and energy non-conservation.

Of course, in light of this one might hold that the mind *does* work through quantum processes *although* this entails momentum/energy non-conservation, the latter being unproblematic. As support, one might cite the 'consciousness collapse' (CC) interpretation of QM, which claims to explain our definite perceptions where quantum formalism predicts superpositions. However, it turns out to be tricky to spell out exactly the relation between states of the non-physical mind and brain states. Also, it might be that CC is already empirically refuted (Yu & Nikolic 2011). The position of CC is all the more weakened with the existence of at least one QM interpretation which explains our observations without recourse to extravagant metaphysics, namely Bohmian mechanics (BM). But BM does not especially support interactive dualism (nor does it disadvantage it). This does not mean, however, that interactive dualists can employ it cheerfully, since any mental interaction entails a change in particle trajectory,

probability distribution or other initial conditions of quantum processes.

It seems, therefore, that the real question interactive dualists must address lies at a deeper level: namely the laws of nature. What is needed is a notion of laws of nature that both does justice to the regularity in nature and the apparent fact of pervasive mental interaction.

**Art Hobson**

I am working on various aspects of the quantum measurement problem, within the context of standard quantum physics without various corrections such as spontaneous collapse, and without specialized interpretations of quantum physics such as the many worlds interpretation. My on-line talk for the Center for the Physics of Living Organisms, titled “Entanglement and the measurement problem," focused on the problem of definite outcomes, also known as the Schroedinger’s cat problem. Here is the abstract: An argument first proposed by John von Neumann shows that measurement of a superposed quantum system creates an entangled "measurement state" (MS) in which macroscopically distinct detector states appear to be superposed, a paradoxical prediction implying the measurement has no definite outcome. We argue that this prediction is based on a misunderstanding of what the MS represents. We show, by studying the phase dependence of entangled photon states generated in parametric down conversion, that the MS represents not a superposition of detector states, but rather a superposition of coherent (i.e. phase-dependent) correlations between detector states and system states. In fact an argument by Einstein shows that a nonlocal entangled state is required, at least briefly, following a quantum system's interaction with a detector. Such a state does not represent a paradoxical macroscopic superposition. This resolves the paradox of indefinite outcomes of measurements.

**Asim Islam**

The approach to employing quantum field theory for memory and brain function was first pioneered by Umezawa and Ricciardi in 1967 by comparing brain electrical activity with properties of condensed matter. More formally, by examining the macroscopic properties of Bose gases which arise from microscopic quantum phenomena it can be shown that by extending the concept to many-body systems applied to thermofield dynamics and condensed states it is a natural requirement to employ a dual state. The notion of duality has been extended to a dissipative model by Celeghini, Rasetti and Vitiello and has been further developed to an extensive model for brain dynamics by Vitiello, Freeman, Jibu, Yasue and others. Neuroscientific studies, based on this model, on humans and animals by Freeman and Vitiello have provided new insights into the nature of perception and cognition which for the first time relate electrical patterns directly to thoughts and perception in a formal scientific manner amenable to quantitative analysis.

The model is presently the most accurate predictor of the empirical outcomes of a wide range of brain electrical activity and is of growing interest amongst quantum physicists and neuroscientists. From a broader perspective, it may also provide a deeper insight into the elusive nature of human consciousness and proposals have been conjectured by Vitiello, Freeman, Jibu and Yasue. Importantly there does not exist any suitable alternative neural network based model which can adequately explain the empirical data. We review the key elements of the many-body quantum brain model with an emphasis on providing a sound physical basis for the approach and providing compelling rationale for pursuing the model.

**Brian Josephson**

I argued a long time ago (*Found. Phys.* 18, 1195-204 (1988), at arXiv:1110.1768) that quantum mechanics has a restricted scope, the way

the state of a system is specified being adequate only in a limited class of situations, which include those addressed in the kind of experiments carried out by physicists, but not those concerning the biological and cognitive sciences. Developments in the latter areas of investigation such as biosemiotics and coordination dynamics offer the possibility of an alternative fundamental basis for science. It is not completely inappropriate to suggest that approaches by physicists involving the attempt to discover a 'theory of everything' based on a set of equations have passed their 'best before' date. My talk, *The Subtleties of Coordination*, can be viewed at this link: https://sms.cam.ac.uk/media/3179345.

**Andrew Knight**

The assumption of algorithmic consciousness implies the ability of conscious states to be copied, leading to a variety of seeming paradoxes, including the problems of duplication/teleportation, simulation, self-location, and the Boltzmann Brain, among others. Despite notable exceptions, few physicists or computer scientists question the assumption that consciousness can be copied or simulated by a computer. In an effort to further elucidate the physical nature of consciousness, I challenge these assumptions by analyzing the implications of special relativity on evolutions of identical copies of a conscious state, particularly the divergence of these evolutions due to quantum fluctuations. By assuming the supervenience of a conscious state on some sufficient underlying physical state, I show that the existence of two or more spacelike instances of the same conscious state leads to a logical contradiction if their respective evolutions depend on independent quantum events; moreover, if evolutions of those instances do not depend on independent quantum events, then quantum no-cloning prevents the existence of more than one copy. I further show that the existence of two or more timelike instances of the same conscious state leads to a comparable logical contradiction, leading ultimately to a refutation of the assumption

that a conscious state can be physically reset to an earlier state or duplicated by any physical means. This conclusion further refutes the notions of mind uploading or simulation, algorithmic or machine consciousness, and Strong Artificial Intelligence.

**John Myers/Hadi Madjid**

As James Peebles put it in his 2019 Nobel Lecture: in the natural sciences "[W]e operate on the postulate that nature operates by rules that we can discover; that's only a postulate---we have no guarantee that that's how nature works---but very productive." Rules, once discovered, permit predictions.

But life in and outside of science is hardly predictable; we all experience surprises. Automotive engineers try to sort out the predictable from the unpredictable; they do not try to predict the route that an automobile will follow over its lifetime; rather, they design it with a steering wheel while also making use of discovered regularities in the strength of steel and the reaction times of people.

Following a proof of the essential non-uniqueness of explanations described in [J. Cog. Sci. 20-2:229-249, 2019], we depart from custom by assigning unpredictability a central place in physics, thereby giving more emphasis to unpredictable agents, including people and other creatures. As an area of application we point out that: agents experiencing unpredictable events need to communicate with one another. They do so as agents by transmitting unpredictable symbols from one to another. We begin to explore mechanisms of symbol handling available to unpredictable agents, and in particular the mutual regulation of rhythms of symbol handling essential to communication of symbols. A recent finding is that rhythms of unpredictable symbols are essential to any application of the concept of spacetime [Meas. Sci. Technol. **31** 025106 (2020)]. For the future we wonder: what role do rhythms of symbols play in animal navigation?

**J. Brian Pitts**

Since Leibniz's time, Cartesian mental causation has been criticized for violating the conservation of energy and momentum. (Non-epiphenomenalist property dualism is analogous.) Many dualist responses clearly fail. But conservation laws have important neglected features generally undermining the objection. Conservation is local, holding first not for the universe, but for everywhere separately. The energy (or momentum) in any volume changes only due to what flows through the boundaries (no teleportation). Constant total energy holds if the global summing-up of local conservation laws converges; it probably doesn't in reality. Energy (momentum) conservation holds if there is symmetry, the sameness of the laws over time (space). Thus, if there are time-places where symmetries fail due to nonphysical influence, conservation laws fail there and then, while holding elsewhere, such as refrigerators and stars.

Noether's converse first theorem shows that conservation laws imply symmetries. Thus conservation trivially nearly entails the causal closure of the physical. But expecting conservation to hold in the brain (without looking) simply assumes the falsehood of Cartesianism. Hence Leibniz's objection begs the question. Empirical neuroscience is another matter. So is Einstein's General Relativity, to be discussed later.

In discussions about whether the conservation of energy and momentum undermine Cartesian mental causation, General Relativity (GR) has rarely been considered. But a few authors have proposed that the non-localizability of gravitational energy and consequent lack of physically meaningful local conservation laws answers the conservation objection to mental causation: conservation already fails in GR, so there is nothing for minds to violate.

This paper is motivated by two ideas. First, one might take seriously the fact that GR formally has an infinity of rigid symmetries of the laws and hence, by Noether's first theorem, an infinity of conserved energies-

momenta (thus answering Schroedinger's 1918 false-negative objection). Second, Sean Carroll has asked (rhetorically) how one should modify the Dirac-Maxwell-Einstein equations to describe mental causation. This paper uses the generalized Bianchi identities to show that General Relativity tends to exclude, not facilitate, such Cartesian mental causation. In the simplest case, Cartesian mental influence must be spatio-temporally constant, and hence 0. The difficulty may diminish for more complicated models. Its persuasiveness is also affected by larger world-view considerations.

**Robert Prentner**

"Biological mentality" opens up a new possibility to conceive of the way that consciousness is related to the physical world. By replacing the dualism mind/brain with a three-stage model of the mind (robotics - "transrobotic" mentality - consciousness), a new option arises: Perhaps, the phenomenon of mammalian consciousness could be explained as "complexification" of a semi-autonomous hierarchy of mental processes (or in fact "mental agents", since transrobotic mentality is assumed to endow such processes with literal desires and intentions)?

This raises some questions – both analytic and synthetic. First, to what extent is the designation "mentality" justified (over and above the properties we could associate with computational processes), and how far does the metaphor go? For example, does it make sense to ask about "phenomenality", i.e. whether "it-is-something-like" for an organism to have transrobotic mentality? And if so, what does this tell us about consciousness? Second, how should one understand that biological mentality complexifies and results in conscious phenomena? Could we construct a formal model of this process which is (i) compatible with the (e.g. evolutionary) principles which informed the framework in the first place, and which (ii) makes concrete empirical predictions?

**Jack Tuszynski**

One aspect of the amazing functioning abilities of the human brain that is seldom discussed is its energetic efficiency. Here, we use simple reasoning based on time, length and energy scales to analyze the possible information processing rates of the human brain based on the metabolic energy cost of encoding a bit of information. We use well-known empirical information about the brain and its constituent neurons and sub-neuronal structures to arrive at characteristic information processing rates at all relevant scales. In order to maintain consistent metabolic rates and clocking frequencies for updating information content, we conclude that only coherently quantum-entangled tubulin dimers in the neuron are likely to operate at a quantum level if their functions include information storage and processing. On the other hand, ion channels, even if unsynchronized may be able to operate in a quantum mechanical regime. It is also relevant in this context to invoke the concept of quantum metabolism as a consistent framework for living systems as opposed to the highly touted quantum biology, which so far has been lacking coherence and synchronization, properties of life in general. Without metabolism, there is no life and without life there is no consciousness. For this reason I believe the story of consciousness should start with the concept of energy transduction.