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Article

Quantum mechanics, free will and the psychophysical problem

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Abstract: Nobel Prize-winning physicist Sir Roger Penrose and Stuart Hameroff, a renowned American physician and scientist, have put forward an innovative theory that the human brain has a quantum mechanism located in the microtubular protein system within neurons, known as the "Orch OR" theory. According to the researchers, this mechanism is responsible for the brain's non-computational actions such as consciousness and free will. This theory has been criticized by several researchers from both the biological and physical sides. The purpose of this paper is to examine whether there is a possible basis for this theory in the philosophy of science.

Keywords: *'Orch OR' theory; free will; quantum mechanics; microtubuli; Leibowitz*

i. Introduction

In their work, Sir Roger Penrose and Stuart Hameroff propose that a quantum mechanism may be responsible for the "non-computational" actions of the human brain, such as free will and consciousness.(Hameroff and Penrose 2014) They propose that the microtubule system of proteins in neurons is the mechanism that carries out these quantum processes. Most criticism of their work focuses on the scientific biological or physical aspects. My purpose is to explore whether their assumptions are justified from a philosophical perspective.

Neurophysiology views the brain as a sophisticated computer that receives sensory input, stores and processes data, and finally produces an output that controls the actions of the organism. My impression is that Penrose and Hameroff understand the brain's function in this way.(Hameroff and Penrose 2014; Hameroff 2021) This type of action can be explained in mechanistic and deterministic terms.

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ii. Free will, determinism and scientific objectivity

The definition and even the existence of free will is a long-standing debate in philosophy.(O'Connor and Franklin 2022) Determinists, libertarians and compatibilists, all have solid views and arguments, and this is not the place to settle this fierce debate. Nevertheless a few words must be said. David Hume stated that the concept of causality is merely a habit of mind resulting from the constant conjunction of events.(Hume 1739) Thus determinism and libertarianism both are impressions of the mind and neither is superior to the other as being grounded in reality. Kant took on the challenge of bringing order to this dispute among metaphysicians. He defined the relationship between the transcendental ego and the "things-in-themselves", and created the familiar division between the phenomenal and noumenal worlds that allows for the simultaneous existence of determinism and free will. He clarified that free will is possible as "the faculty of starting an event spontaneously".(Kant 1783) Leibowitz, a 20th century neo-Kantian thinker, claimed in his 1970 essay on the psychophysical problem that subjective human experience cannot be studied by the scientific method. Scientific objectivity is defined by the necessity of conclusions, while subjective beliefs and ethical decisions are not determined and have no inherent necessity.(Leibowitz 1970) This understanding is compatible with Kant:

> "all the actions of rational beings, so far as they are appearances, fall under •the necessity of nature; but •those same actions, considered purely in terms of the rational subject and its ability to act according to mere reason, are •free".(Kant 1783)

Free will is defined as the pursuit of a goal, moral value, or ideal that does not yet exist and can be realized in the future. Deterministic action is defined as mechanistic action caused by an event in the past. Accordingly, free will action is determined by the possible future and is not caused by events in the past.

iii. Quantum physics

Mechanisms that obey the rules of classical physics act according to absolute laws of determinism. Pressing the "on" switch on a machine always has the same consequence if the machine is working properly. The actions of quantum mechanical systems can be described by the well-known Schrödinger equation(Schrödinger 1926) and Born's rule in the quantum superposition state, i.e. in the past. The measurement causes the collapse of the wave function and the transition from the quantum to the classical state. In contrast to the orthodox Copenhagen interpretation, the Penrose interpretation with respect to quantum collapse (objective reduction) assumes that the collapse is caused by gravity and not by an observation or a measurement.(Penrose 2014)

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Stapp takes a different view that is more consistent with the Copenhagen interpretation:

> "the agent whose rationality is intrinsically related through their will to the measurements that determine outcomes in quantum mechanics, cannot be eliminated in any procedural or reductive way" (De Barros et al. 2019),

And explains in a purely Kantian way:

> "Science thus provides man with at least the rudiments of a cohesive view of nature in which his own thoughts and actions are integral parts of a universe that generates meaningful options via the laws of nature, but is not rigidly controlled by these laws".(Stapp 2009)

In both cases, the particular properties of a single particle cannot be calculated in advance, but can only be measured in the physical world. However, the classical properties of a single particle after quantum collapse are determined by the wave function, i.e. by the past. The state of a single particle does not behave exactly according to the rules of classical physics, but it is given by past events and cannot go beyond the predictions of the Schrödinger equation. The state of billions of particles in real world systems and organisms, on the other hand, can be accurately predicted by the Schrödinger equation and is in turn caused by past events and is accordingly deterministic. Finally, even a man-made quantum computer executes a set of predetermined instructions and produces a completely predictable result, as David Deutsch pointed out: "The output state of a quantum machine, although fully determined by the input state is not an observable and so the user cannot in general discover its label".(Deutsch and Penrose 1985)

iv. Microtubuli and their action

The human brain consists of about 86 billion neurons.("Are There Really as Many Neurons in the Human Brain as Stars in the Milky Way? | Brain Metrics | Learn Science at Scitable" n.d.) Microtubules are cylindrical structures abundant within the neuron that can generate electrical oscillations(Cantero et al. 2018) and "beyond their known conventional functions in supporting neuronal architecture and organelle transport, microtubules may act as "information carriers" in the neuron".(Dent and Baas 2014) They are composed from subunits each 50 kDa.(Desai and Mitchison 1997) Thus the amount of atoms or even subunits constituting microtubules in the brain is at least in the many billions range. Even if Penrose and Hameroff are right in their assumption and the microtubuli act as a quantum mechanism that controls some brain action; due to the large numbers, their action is determined by the past (quantum superposition state) and can be predicted by the Schrödinger equation and the Born rule i.e. deterministic.

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v. Conclusion

Non-deterministic actions such as free will cannot be explained by quantum mechanics because it is inherently deterministic, which is obvious when dealing with a large number of particles or components. The description of the human brain as an extremely complicated and sophisticated machine cannot explain subjective qualities such as consciousness, self- awareness, and free will; these qualities cannot even be formalized as computational problems.(Leibowitz 1970) The addition of a quantum mechanism to the brain does not abolish causality, but merely adds a random effect to the outcome that is still within the predictions of the Schrödinger equation. It may give the appearance of unpredictability, but not the actual effect of free will. Even if the human brain has a mechanism (which could theoretically even be quantum mechanical) that analyzes possible futures based on past experience, the final choice of action should be dictated by the human psyche if free will actually exists. Similar to Stapp, I believe that the "participant observer" cannot be taken out of the equation. I can summarize this in Wittgenstein's words: “the feeling of the unbridgeability of the gap between consciousness and brain process”.(Wittgenstein and Schulte 2003)

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