

THE BRAIN MICROBIOTA AS IT RELATES TO THE ORCH OR THEORY OF CONSCIOUSNESS

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Abstract

I propose to incorporate the concepts of brain microbiota and microbial consciousness in the Orch OR theory of human consciousness with the goal of increasing its explanatory and predictive powers. If consciousness arises from quantum computations in cytoskeletal structures inside human neurons, there is no theoretical impediment at hypothesizing that it might also occur in the cytoskeletal structures of the microbes resident in our brains. If the concept of the brain microbiota could be integrated in a general Orch OR theory, its explanatory and predictive powers would be vastly increased.

Introduction

A recent article by Hameroff describes Orch OR as "the most complete, and most easily falsifiable theory of consciousness" (Hameroff, 2021). The Author proposes an experiment, based on exposure to anesthetic gases, that would confirm or reject the theory that consciousness is based on quantum computations occurring inside microtubules of brain neurons rather than in the plasticity of the web of connections established between cells of the central nervous system as proposed by the majority of theories of consciousness (Doerig et al., 2021). Hameroff presents five paradigm cases that support his statement and confer the validity of the Orch OR theory. Here, I introduce a sixth paradigm case that should be taken into consideration in designing experiments aimed at falsifying the Orch OR or any other theory of consciousness.

The brain microbiota

Hameroff and all those concerned with theories of consciousness focus their attention on the human cells of the brain, neurons and glial cells, but do not take into account the presence of microbial cells that constitute the brain microbiota, whose influence on brain function is nothing less than "immense" (Branton et al., 2013). The first description of bacterial cells in the brains of healthy individuals was published in 2013 (Branton et al., 2013); the term "brain microbiota" in the context of neurological diseases was used for the first time in 2016 (Ruggiero, 2016). In 2018, ultrastructural studies demonstrated abundance of microbial cells in the areas associated with reward-seeking, learning, memory and consciousness, *i.e.* the substantia nigra, the hippocampus and the pre-frontal cortex (Roberts et al., 2018). The microbes in our brains are the same that are found in soil and water; it has been hypothesized that they reach the brain carried by cells of the immune system as well as travelling along the axons of peripheral nerved (Branton et al., 2013; Roberts et al., 2018). Whatever the case, just as it would be unrealistic today to discuss the function of the gut, or that of the immune system, without considering the essential role of the microbiota (Wu and Wu, 2012), I propose that also the discussion on the different theories of consciousness, and, in particular, Orch OR, should take into account the role of the brain microbiota.

Microbial consciousness

If consciousness arises from quantum computations occurring in cytoskeletal structures inside human neurons, there is no theoretical impediment at hypothesizing that cytoskeletal structures of microbes could give rise to forms of consciousness or awareness. Microbial consciousness arising from the cytoskeleton was described in 2017 (Reddy and Pereira, 2017) and this concept was further elaborated in an essay published in 2019 where the Authors postulate that subjective awareness emerged as an intrinsic feature of the first unicellular forms of life through the working of oscillating cytoskeletal structures, and structurally flexible proteins, that is, in a manner closely reminiscent to the concepts at the basis of Orch OR (Baluska and Reber, 2019). If phenomena of quantum entanglement occur between the microtubules of adjacent neurons (Hameroff and Penrose, 2014), they may also occur between the cytoskeletal structures of human neurons and those of the microbes of the brain microbiota as well as between the cytoskeletal structures of the different microbes.

Implications for the design of experiments

In designing an experiment to prove Orch OR, Hameroff proposes to expose the brain to anesthetic gases and observe whether dampening of quantum interference beats in tubulin and microtubules occurs (Hameroff, 2021). However, volatile anesthetics affect bacterial functions such as motility, biofilm formation and signal transduction (Chamberlain et al., 2017). Of particular significance are the effects on biofilm formation since this phenomenon is paradigmatic of the so-called microbial intelligence (Westerhoff et al., 2014). In short, in designing the experiment to prove Orch OR, the effects of volatile anesthetics on the brain microbiota should be considered in order to prevent potential misinterpretation of the results.

Conclusion

Orch OR might indeed be the most complete theory of consciousness even though it has to be considered special or relative to the human part of the brain; if the concept of the brain microbiota and the ensuing concept of the rhizome (Ruggiero, 2017) could be

integrated in a general Orch OR theory, its explanatory and predictive powers would be vastly increased.

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References

Baluška F, Reber A. Sentience and Consciousness in Single Cells: How the First Minds Emerged in Unicellular Species. *Bioessays*. 2019 Mar;41(3):e1800229. doi: 10.1002/bies.201800229. Epub 2019 Feb 4. PMID: 30714631.

Branton WG, Ellestad KK, Maingat F, Wheatley BM, Rud E, Warren RL, Holt RA, Surette MG, Power C. Brain microbial populations in HIV / AIDS: α -proteobacteria predominate independent of host immune status. *PLoS One*. 2013;8(1):e54673. doi: 10.1371/journal.pone.0054673. Epub 2013 Jan 23. PMID: 23355888; PMCID: PMC3552853.

Chamberlain M, Koutsogiannaki S, Schaefer M, Babazada H, Liu R, Yuki K. The Differential Effects of Anesthetics on Bacterial Behaviors. *PLoS One*. 2017 Jan 18;12(1):e0170089. doi: 10.1371/journal.pone.0170089. PMID: 28099463; PMCID: PMC5242519.

Doerig A, Schurger A, Herzog MH. Hard criteria for empirical theories of consciousness. *Cogn Neurosci*. 2021 Jan-Jan;12(2):41-62. doi: 10.1080/17588928.2020.1772214. Epub 2020 Jul 14. PMID: 32663056.

Hameroff S, Penrose R. Consciousness in the universe: a review of the 'Orch OR' theory. *Phys Life Rev*. 2014 Mar;11(1):39-78. doi: 10.1016/j.plrev.2013.08.002. Epub 2013 Aug 20. PMID: 24070914.

Hameroff S. 'Orch OR' is the most complete, and most easily falsifiable theory of consciousness. *Cogn Neurosci*. 2021 Jan-Jan;12(2):74-76. doi: 10.1080/17588928.2020.1839037. Epub 2020 Nov 24. PMID: 33232193.

Reddy JSK, Pereira C. Understanding the emergence of microbial consciousness: From a perspective of the Subject-Object Model (SOM). *J Integr Neurosci*. 2017;16(s1):S27-S36. doi: 10.3233/JIN-170064. PMID: 29254105.

Roberts RC, Farmer CB, Walker CK. (2018) The human brain microbiome; there are bacteria in our brains! 594.08/YY23. Session 594. Neuroscience. 2018. Neuroimmunology: Regulating Systems. <https://www.abstractsonline.com/pp8/#!/4649/presentation/32057>

Ruggiero M. Fecal Microbiota Transplantation and the Brain Microbiota in Neurological Diseases. *Clin Endosc*. 2016 Nov;49(6):579. doi: 10.5946/ce.2016.098. Epub 2016 Nov 11. PMID: 27832684; PMCID: PMC5152774.

Ruggiero M. The Human Microbiota and the Immune System; Reflections on Immortality. *Madridge J Immunol*. 2017; 1(1): 18-22. doi: 10.18689/mjim-1000106

Westerhoff HV, Brooks AN, Simeonidis E, García-Contreras R, He F, Boogerd FC, Jackson VJ, Goncharuk V, Kolodkin A. Macromolecular networks and intelligence in microorganisms. *Front Microbiol*. 2014 Jul 22;5:379. doi: 10.3389/fmicb.2014.00379. PMID: 25101076; PMCID: PMC4106424.

Wu HJ, Wu E. The role of gut microbiota in immune homeostasis and autoimmunity. *Gut Microbes*. 2012 Jan-Feb;3(1):4-14. doi: 10.4161/gmic.19320. Epub 2012 Jan 1. PMID: 22356853; PMCID: PMC3337124.