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Peer Review

Review of: "Multi-Scale Temporal Resonance Theory of Consciousness (MSTRT): From Molecular Mechanisms to Minimal Functional Specifications, Necessary and Sufficient Conditions, and the Role of Sensory Input, Memory, and Motivational Drive"

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The paper presents a theory of human consciousness based on several assumptions. The connection between the assumptions and the first-person experience of being conscious is not discussed, but the author reviews neuroscientific evidence about necessary conditions for a human person being awake and responding to what happens.

The standard of the paper is high compared to other papers on consciousness. The author reviews the three main theories and uses mostly a recent proposal by Aru et al.

The strength of the paper is the mathematical development of the connection between the mechanisms assumed to be necessary for conscious processing:

- calcium backpropagation in apical dendrites of layer 5 pyramidal neurons
- amplitude and phase coupling of synchronized large-scale oscillations
- coincidence detection by glutamatergic NMDA channels.

Some possible weaknesses of the reasoning are:

- Calcium entry through NMDA channels has been reported (Kandel) to trigger signal-transduction pathways related to memory formation, while calcium spikes and signal backpropagation may be

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mostly dependent on voltage-gated calcium channels

- Oscillatory synchrony at several (delta, theta, alpha, beta, gamma) frequencies cannot be a function of a type of pyramidal neuron alone, because they involve thalamocortical loops that activate other types of neurons
- Communication by means of gap junctions is mostly a property of astrocytes, not neurons. The theory does not include astrocytes in the process of generation of large-scale synchronized oscillations.
- Consciousness depends not only on 40 Hz synchronized oscillations, but on a bundle of other frequencies (see the work of Palva and Palva, Phase synchrony among neural oscillations in the human cortex, J. Neurosci, 2025)
- The hypothesis of coincidence detection by means of NMDA channels, although sound in itself, needs to be inserted into the synchronous oscillation generation process.
- The references to the claustrum, to ephaptic coupling, to quantum effects, to neuromodulation, and to dissipation are not well integrated with the proposed mechanism

Declarations

Potential competing interests: No potential competing interests to declare.