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# Addressing Searle's "Problem of Consciousness"

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## ABSTRACT

*The philosopher John Searle bemoaned the inadequate scientific descriptions of consciousness. In questing for an empirical theory of consciousness, he focused on 4 issues:*

1. ***[Definition]:** What is consciousness?*
2. ***[Process]:** Relationship between consciousness and brain activity?*
3. ***[Materials]:** What are specific features (of consciousness)?*
4. ***Mistakes** common to neurobiologists and cognitive scientists.*

*We surmount these points by invoking a biochemical rationale for the emerging talent of complex neural nets, namely "memory." The tripartite mechanism of neural memory describes neurons interacting with their surrounding extracellular matrix (nECM), deploying dopants (metal cations and neurotransmitters (NTs)) to form cognitive units of information (cuinfo) (Marx & Gilon, 2012 – 2020). Each NT elicits a unique set of physiologic responses entangled with psychic (emotive) states and is also employed to encode emotive cuinfo within the nECM.*

*None can deny that without memory, there is no consciousness. Consciousness emerges from the neural net's signaling process transduced into a mental, subjective dimension. It evolved from bacterial signaling with biogenic amines, which are still employed by neurons. The tripartite mechanism avoids the fallacy of depending exclusively on synaptic, electrodynamic signaling as underlying mentality. Rather, it permits the evolution of chemo-dynamic processes by which neurons encode sets of cuinfo, from which memory is integrated.*

*Thus, we respond to Searle's problems by proposing a chemo-dynamic mechanism whereby neural nets generate a new mental activity dimension, manifest as conscious experience and subjective memory.*

## Keywords

Consciousness/Tripartite mechanism/ neurotransmitters/emotions/ phase change/ mentality.

## Background

The explosion of knowledge about brain processes over the past few decades makes it almost impossible to integrate the findings of pertinent disciplines (anatomy, neurobiology, psychoanalysis, biochemistry, and computers) into a unified mental process model [1].

For example, Artificial Intelligence (AI) simulation programs that aim to comprehend human commands, languages, and interactions [2], have been considered models for how neurons achieve consciousness. But in the absence of means to encode emotive states [3,4], such modeling is questionable.

Emerging research suggests that multi-scale processes in the brain arise from so-called "critical phenomena" that occur very broadly in the natural world. Notwithstanding neuro-imaging techniques, such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and electroencephalogram (EEG), do not clarify the emergence of mental talents from neural tissue [5,6]; it is rarely mentioned.

*Q: How is neural activity integrated across anatomic scales to give rise to cognitive function such as memo?*

"Awareness" and "consciousness" might be considered to be identical terms. Generally, consciousness is related to memory—the ability to store and retrieve relevant information. It may be looked upon as an adaptive capacity enabling organisms to adjust to their ever-changing physical environment. A unified brain-mind model should explicitly describe how the brain achieves consciousness and essentially provides a mentation theory.

Exploring the phenomenon of consciousness, John Searle (noted philosopher 1993) focused on 4 issues:

1. **[Definition]:** What is consciousness?
2. **[Process]:** Relationship between consciousness and brain activity?
3. **[Materials]:** What are the specific features?
4. **Mistakes** common to neurobiologists and cognitive scientists.

We tackle these issues one-by-one, as follows:

**1.** We consider that the **causal phenomenon of consciousness** due to neuro-chemical processes described as a tripartite mechanism [7-9]. Consciousness is an expression of neural net activity based on chemical signaling between neurons. Such chemical signaling evolved from bacterial aggregates, which employ biogenic amines, termed "modulators" [10] as signals. The evolved neurons employed the same molecules (now called "neurotransmitters (NTs)) and developed "neuropeptides," all to signal an affective chemical code, as outlined by the tripartite mechanism. Neural nets also developed an alternate electrodynamic signaling system through synapses to control distal muscles and organs. Ultimately, neural net consciousness partakes of both chemo-dynamic and electrodynamic signaling modalities. But only chemical signals elicit the dimensions of subjective experience i.e. emotions. Aside from NTs, consider the cornucopia of "mind-altering" drugs (chemicals) used worldwide to modulate memory and mental state (i.e., Prozac, Valium, cocaine, Ecstacy, etc.). Notwithstanding, most expositions on consciousness do not consider psycho-chemical processes [11,12]. In our opinion, a working model of how the brain generates mentality needs to meld various physiologic effects and biochemical processes. A "paradigm shift" is called for.

One could consider mentality to be a new form of metabolic energy, phase changed (transcended) into a subjective state which emerges from the increasing complexity of neural interactions (Figure 1). This is analogous to photons' emission (laser light) from electrically activated chips, also a phase-change phenomenon [13]. An experimental estimate of the energy cost of conscious versus unconscious (vegetative) states, was obtained by PET rCBF (regional cerebral blood flow) scanning technique. It revealed: "massive drops in cortical metabolism" [5]. The example of biology indicates that at least 300 neurons (i.e., *C. Elegans*) are required to achieve the transcendence of metabolic energy into memory [14]. The evolution of larger and more complex neural aggregates has paralleled the emergence of more complex mental talents (Figure 1).

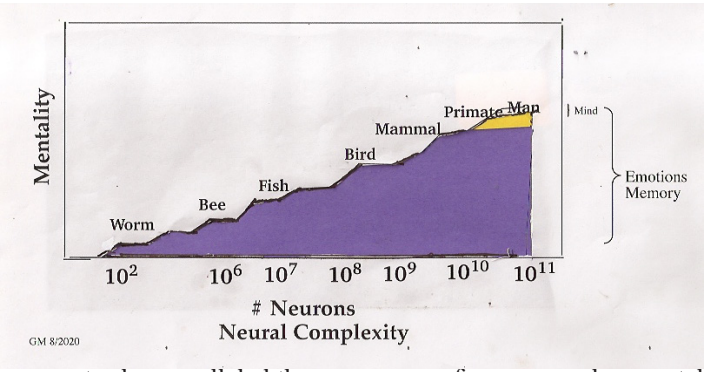


**Figure 1:** The emergence of conscious mental states reflecting the evolving size and complexity of neural net signaling.

**2. The relation of consciousness to the brain** is one of functional identity. Without a functioning brain, consciousness cannot be experienced. Searle opined that electro-biochemical processes in the brain cause consciousness. But he did not elaborate on the" processes".

Most modern neurobiologists focused on electrodynamic, synaptic signaling, measuring spikes, and irregularities in discharge timing [15,16]. But they have not grappled with the emergence of mental states or consider psycho-chemical rationales.

*Q: How are subjective states achieved?*

We describe a biochemical process (a tripartite mechanism) involving NTs, that neural nets employ to achieve a new dimension, a subjective experience recalled as emotive memory.

**3.** As for **features and materials** that support such processes, the tripartite mechanism calls on three physiologic compartments: neurons, extracellular matrix (nECM) [17], and dopants (metal cations and neurotransmitters (NTs). The neurons and nECM are essentially static; the dopants are mobile and diffusible but capable of being trapped within the nECM to form metal-centered complexes (*cuinfo*) (Figure 2). The NTs instigate and encode emotive states melded to physiologic reactions (Table 1).

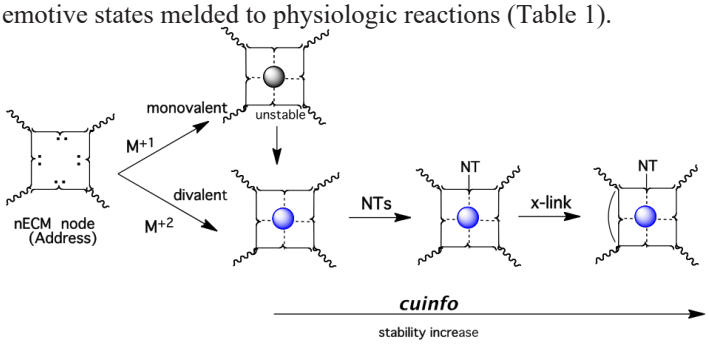


**Figure 2:** Formation of *cuinfo* complexes with different monovalent and polyvalent metal cations and different neurotransmitters (NTs) were all rendered more stable by crosslinking.

**4.** As for **common mistakes** by neurobiologists and cognitive scientists, we point out a few:
Ignoring neural morphology and the nECM as relevant to neural signaling [7].

- Focusing exclusively on electrodynamic signaling through synapses but ignoring chemo-dynamic, non-synaptic (ephaptic) signaling [18;19]. Chemo-dynamic processes involving NTs elicit physiologic reactions and instigate mental states (Table 1). Others have noted that there is dopamine-, noradrenaline- and serotonin- communication channels in forebrain neurons [20].
- Considering computer processing as a model for brain mentation. Various groups attempted to imbue algorithmic programs with affective qualities, but with little success [21-27]. Their inability to do so underlies the difficulty of encoding neural subjectivity.
- Attempting to address consciousness with the metric of quantum mechanics [7,28]. Without an emotive quality, the conscious neural creature cannot establish the "worth", "value", or "meaning" of any sensorial input. Without an emotive quality, "demotive" robots perform as "Frankenstein" devices.

**Table 1:** Neurotransmitters (NTs), which elicit both physiologic reactions and psychic states.

| Neurotransmitter (NT) | Physiologic reactions * (sensation, feelings) | Psychic states** |
|---|---|---|
| Acetylcholine (1)<br>Amino acids (>10)<br>Biogenic amines (8)<br>Neuropeptides (>70)<br>Endocannabinoids (>10)<br>NO (1)<br>(trace metals; >10) | Breathing<br>Blinking<br>Blood pressure<br>Coagulation, b.pressure<br>Cold (feel)<br>Contraction of muscles<br>Coughing<br>Cramps<br>Crying<br>Defecation<br>Dilation of muscles<br>Dilation of pupil<br>Drooling<br>Erection<br>Evacuation<br>Fever<br>Goosebumps<br>Heartbeat<br>Heat (feel)<br>Hunger (feel)<br>Immune reactions<br>Itching<br>Pain<br>Retching<br>Seeing<br>Shivering<br>Smelling<br>Thirst (feel)<br>Touching<br>Vomiting | Anxiety<br>Aggression<br>Awareness<br>Curiosity<br>Depression<br>Desire<br>Dread<br>Dreams<br>Fantasy<br>Fear<br>Hate<br>Joy<br>Love<br>Paranoia<br>Sadness<br>Sex drive<br>Sociability |
| | * No memory required. | **Emotions requiring memory |

## Discussion

Here, we focus on the 4 problems of consciousness enumerated by John Seale [29]. This is reminiscent of the 23 problems of physics presented to mathematicians by David Hilbert (~ 1900). Some are still not solved, but they stimulated work in various mathematical fields.

Similarly, Searle's enunciation of 4 problems of consciousness instigated our response, as elaborated above. We assign the physiologic aspects of memory to a tripartite mechanism, which underlies all subjective consciousness aspects. We propose that the neural net transcends metabolic energy into mental states and memory, as schematized in Figure 3.

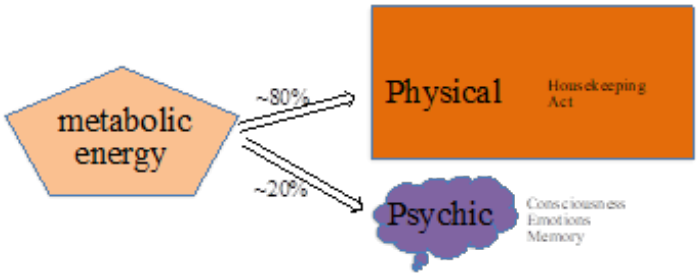


**Figure 3**. Schematic of the division of metabolic energy into physical performance and psychic talents, experienced as emotions, memory, and consciousness.

## Conclusion

We should be courageous and admit that the metrics of physics are not adequate to describe mental states. Clearly, memory and emotions are co-joined aspects of "consciousness". May Searle's problems stimulate cognitive scientists to resolve the causal mechanisms driving the emergence of mentality from the activity of neural circuits.


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GM CG: We note that Professor Gallistel's (Rutgers University) remarks drew our attention to "memory" as the proper focus of our speculations.


## Conflict of Interest

GM is a founder of MX Biotech Ltd., with the commercial goal to develop new "memory materials" and devices.

CG is an emeritus professor at the Institute of Chemistry, The Hebrew University of Jerusalem. He is active in developing technologies for the conversion of peptides and active regions of

proteins into orally available drugs.

Notwithstanding, the ideas forwarded here are scientifically genuine and presented in good faith, without commercial clouding of the concepts expressed therein.

## References


1. Pally R. The Mind-Brain Relationship. Routlege, London. 2000.
2. Russell S. Commentary: Should we fear robots? Scientific American. 2016; 58-59.
3. Steunebrink BR. The Logical Structure of Emotions. Thesis Nederlands ISBN. 978-90-393-5329-5. 2020.
4. Tambini A, Rimmele U, Phelps E, et al. Emotional brain states carry over and enhance future memory formation. Nat Neurosci. 2017; 20: 271-278.
5. Dehaene S, Changeux JP. Experimental and theoretical approaches to conscious processing. Neuron. 2011; 70: 200-227.
6. Cocchi L, Gollo LL, Zalesky A, et al. Criticality in the brain: A synthesis of neurobiology, models and cognition Progress in Neurobiology. 2017; 158: 132-152.
7. Marx G, Gilon C. Interpreting neural morphology. Acta Scientific Neurology. 2020; 3: 1-4
8. Marx G, Gilon C. Tripartite mechanism of neural memory: Proof-of-concept with neuromimetic impedence electrodes. Biomedical Research and Clinical Review. 2020; 1: 21.
9. Marx G, Gilon C. The Molecular Basis of Neural Memory. Part 11. Chem-electric Write /Read Processes. J. Neurosurg. Imaging Techniques. 2020; 6: 283-301.
10. Roshchina VV. Evolutionary considerations of neuro-transmitters in microbial, plant, and animal cells. Lyte M, Freestone PPE (eds.), Microbial Endocrinology, Inter-kingdom Signaling in Infectious Disease and Health, Chapter 2 Springer Science+Business Media, New York. 2010.
11. Chalmers DJ. The puzzle of conscious experience. Sci Amer. 1995; 62-68.
12. Crick F, Koch C. Why neuroscience may be able to explain consciousness. Sci Amer. 2002; 94.
13. Amiri IS, Azzuhri SRB, Jalil MA, et al. Introduction to photonics: Principles and the most recent applications of microstructures. Micromachines (Basel). 2018; 9: 452.
14. White G, Southgate E, Thomson JN, et al. The Structure of the Nervous System of the Nematode Caenorhabditis elegans. Philos. Transact. R. Soc. London. Series B, Biological Sciences. 1986; 314: 1-340.
15. Shadlen MN, Newsome WT. Noise, neural codes and cortical organization. Curr. Opin. Neurophysiol. 1994; 4: 569-579.
16. Hofman MA. Of brains and minds. A neurobiological treatise on the nature of intelligence. Evolution and Cognition. 2003; 9: 178-188.
17. Dityatev A, Seidenbecher CI, Schachner M. Compart-mentalization from the outside: The extracellular matrix and functional microdomains in the brain. Trends in Neurosciences. 2010; 33: 503-511.
18. Anastassiou CA, Perin R, Markram H, et al. Ephaptic coupling of cortical neurons. Nature Neuroscience. 2011; 14: 217-223.
19. Bailey CH, Giustetto M, Huang YY, et al. Is heterosynaptic modulation essential for stabilizing Hebbian plasticity and memory? Nature Reviews Neuroscience. 2000; 1: 11-20.
20. Fuxe K, Dahlström A, Höistad M, et al. From the Golgi-Cajal mapping to the transmitter-based characterization of the neuronal networks leading to two modes of brain communication: wiring and volume transmission. Brain Res Rev. 2007; 55: 17-54.
21. Boole G. The Laws of Thought. The Mathematical Theories of Logic and Probabilities. Project Gutenberg (EBook #15114); Released: Feb. 2005. 1853.
22. Arbib MA. Brains, Machines and Mathematics. 2nd Edition. Springer Verlag, New York. 1987.
23. Arbib MA. Warren McCullogh's search for the logic of the nervous system. Perspect. Biol. Med. 2000; 43: 193-216.
24. Picard R. Affective Computing. MIT Press, Boston. 1997.
25. Hasson C. Modelisation des mecanismes emotionnels pour un robot autonome: perspective developpementale et sociale. Universite de Cergy Pontoise, PhD Thesis, France. 2011.
26. Guidolin D, Albertin G, Guescini M, et al. Central nervous system and computation. Quart. Rev. Biol. 2011; 86: 265-285.
27. Fingelkurts AA, Fingelkurts AA, Neves CHF. "Machine" consciousness and "artificial" thought: An operational architectonics model guided approach. Brain Research. 2012; 1428: 80-92.
28. Wheeler JA. Recent thinking about the Nature of the physical world: It from bit. NY Acad Sci. 1992; 655: 349-352.
29. Searle JR. The problem of consciousness. Consciousness and Cognition. 1993; 2: 310-319.