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Consciousness in Neural Chimeras & Organoids

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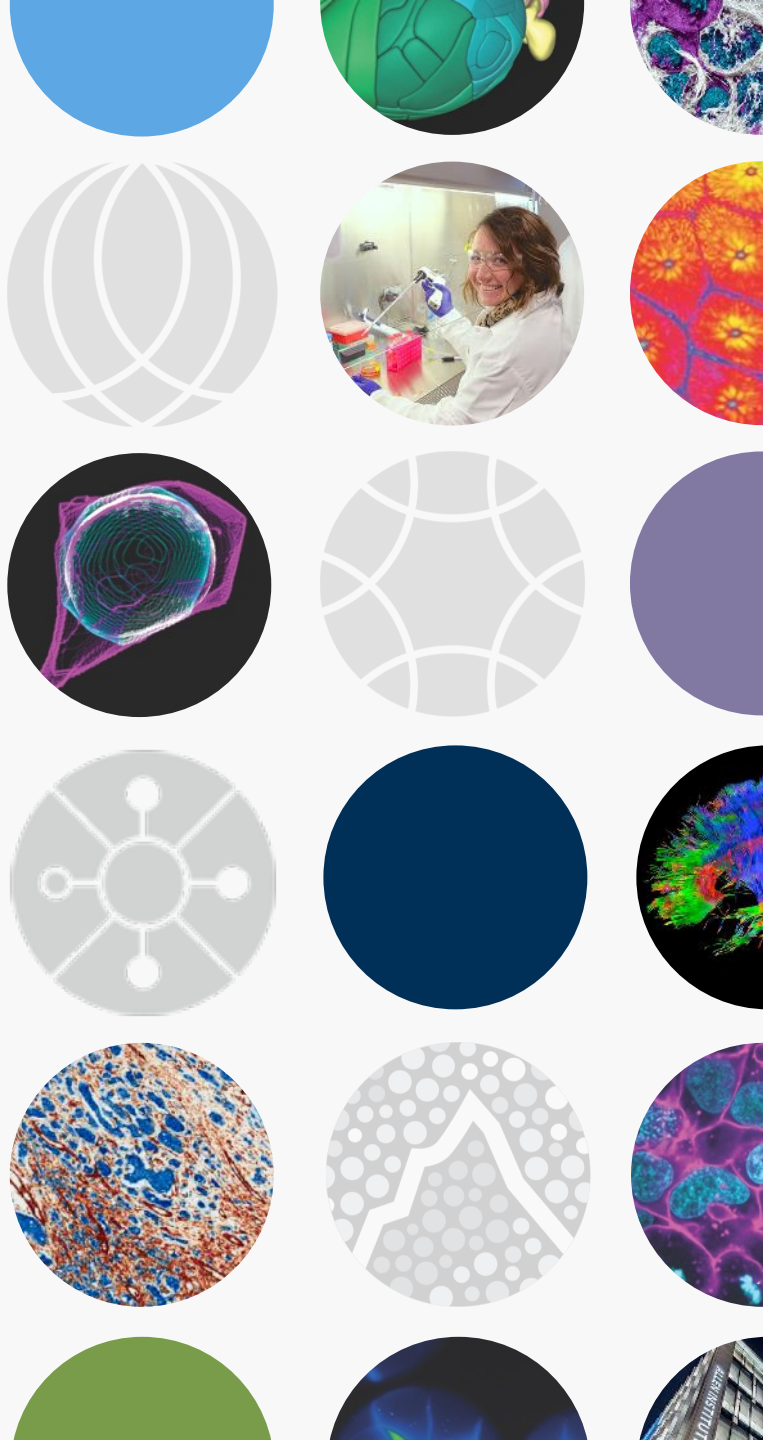

Consciousness is any Experience

- Consciousness is any experience, anything that “feels like something” (Nagel, 1974) including
- externally-triggered sensory percepts,
- internally-generated body-centered percepts,
- emotions, self awareness, thoughts, imaginations,
- memories,
- dreams,
- mystical experiences.

Preamble

- Consciousness is always inferred as it can never be directly observed except in ourselves
- This inference is a form of *abductive reasoning* as the most likely explanation of all known facts
- We usually infer consciousness in adults, babies, patients, and in non-human animals based on language or other non-stereotyped behaviors
- Consciousness in minimal conscious or unresponsive wakefulness patients can be inferred based on complex cortical responses (*zap-and-zip;* Casarotto *et al.* 2017)
- *Consciousness* is quite different from *intelligence*; the former is about *being* while the latter is concerned with *doing*

Christof Koch *The Feeling of Life Itself* 2019

Cerebral Organoids

- Derived with patterned protocols from human induced pluripotent stem cells after 9-12 months in incubator and culture
- Transcriptionally, organoids resemble first & second trimester human embryonic forebrain neurons
- Several mm across, with up to 10^6 glutamatergic and GABAergic neurons, glial cells & (intermediate) progenitor cells
- Electrical and synaptic activity, including LFP comparable to aspects of EEG *trace discontinue* of preterm human infant (burst-suppression; Trujillo *et al.* 2019)

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Current Consensus

- Based on everything we know about the brain basis of consciousness, there is no reason to believe that cerebral organoids, as of 2020, are conscious in any meaningful sense.
- It is possible that the rapidly advancing field of stem cell biology could produce brain organoids capable of exhibiting features that, in a human brain, would be considered hallmarks of consciousness.

Is this Brain Organoid Conscious? - *Jeziorski, Brandt, Churchland, Evans, Campana, Kalichman, Thompson, Goldstein, Koch & Muotri,* submitted

Chimera

- Non-human animals with human-derived neural tissue
- Enhanced behavior of host animals (e.g., Han *et al.* 2013)
- As of today, no evidence for qualitative different behavior or cognitive capacities (e.g. mice carrying a humanized FOXP2 gene do not become linguistic competent)
- Unless the number of humanized cells dramatically increase in host animals, it is unlikely qualitative new behaviors will emerge
- Thus, from the point of view of consciousness, chimeric animals fall under the standards established for the welfare of non-chimeric animals.

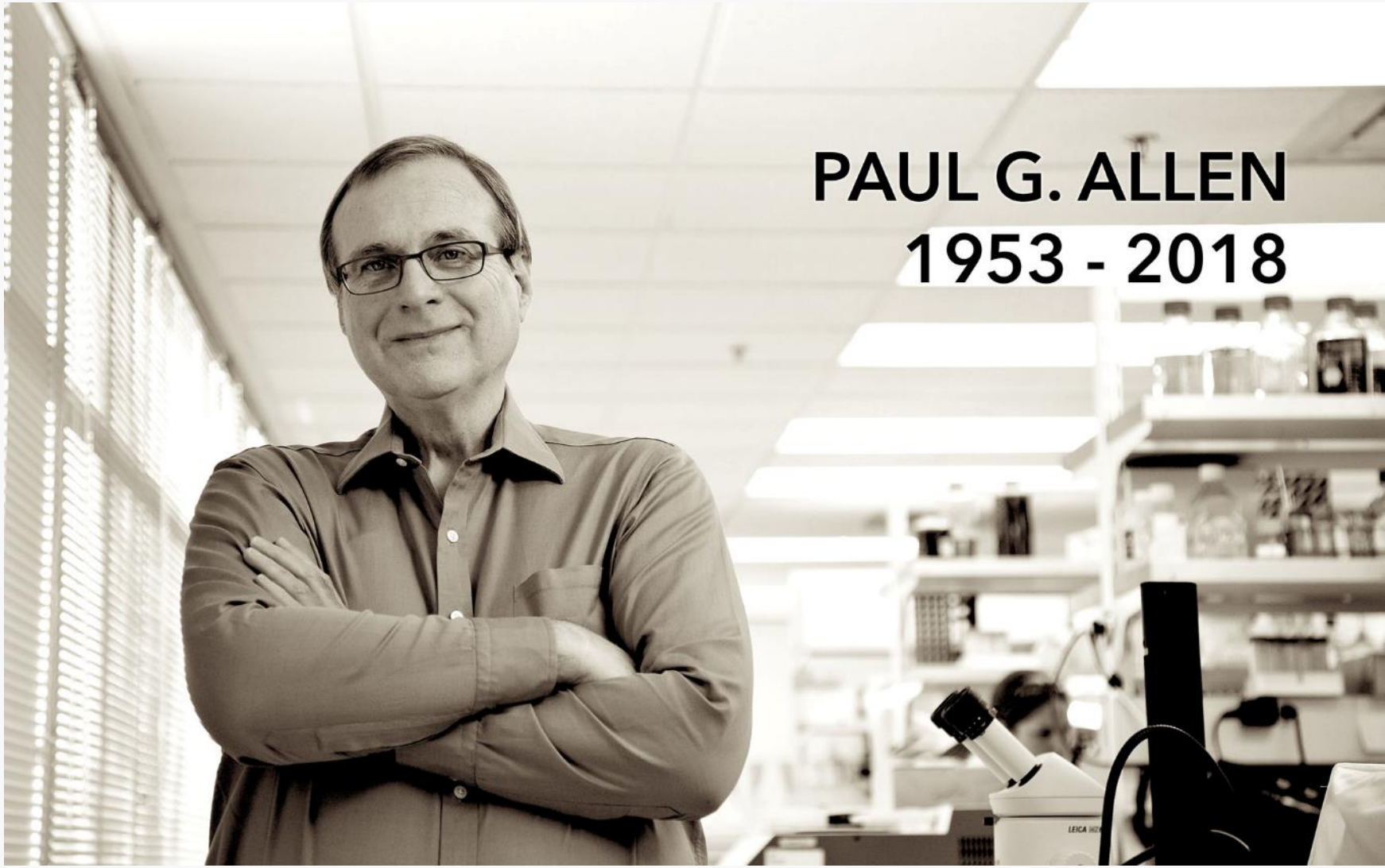
An Urgent Empirical Research Program

- Search for the minimal neuronal mechanisms jointly sufficient for any one conscious perception, the *neuronal correlates of consciousness* (NCC).
- Such a research program is essential for the basic and clinical neuroscience community to find a consensus regarding how the presence or absence of consciousness in brains can best be measured.

Crick & Koch *Nature* 1995

THANK YOU

We wish to thank the Allen Institute founder, Paul G. Allen, for his vision, encouragement, and support.



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