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What we (can) know about consciousness

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A Viewpoint on the Frontiers in Science Lead Article

Consciousness science: where are we, where are we going, and what if we get there?

Key points

- Despite decades of investigation, there is still a lack of consensus on answers to many key questions in consciousness research.
- Split-brain and hemispherectomy patients offer unique insights into questions surrounding the unity of consciousness and its neural substrates.
- Phenomenological aspects of consciousness can only be reliably investigated in humans capable of self-report.

Gradually returning to consciousness while emerging from general anesthesia after surgery one morning, my disorientation slowly gave way to a realization. Not long after my awakening, it occurred to me that I had agreed to write a viewpoint article for Frontiers in Science that was due the next day. Here is that viewpoint!

As any student of consciousness knows, one key distinction in the field is between the idea of *levels* of consciousness (my awakening from anesthesia as a prime example of going from 0 to 100) and the *contents* of consciousness (my panicked thoughts upon realizing the impending article deadline). The lead article “Consciousness science: where are we, where are we going, and what if we get there?” authored by Cleeremans, Mudrik, and Seth, is an outstanding, clear-eyed roadmap of the landscape of contemporary consciousness research and its possible futures (1). “Consciousness” is such a complicated and controversial term that even these intrepid authors put aside a formal definition in their treatment of the topic. When I was a member of the Brain, Mind, and Consciousness program at the Canadian Institute for Advanced Research (through which I have had the pleasure of interacting with these authors), I found that a group of individuals who care deeply about this topic and have made it their life’s work could easily engage in a year of robust discussion and still not

arrive at a definition of consciousness that satisfied every member. As the authors concede in their text, “there is not only a lack of agreement about the answers in consciousness science but also a lack of consensus about approaches and relevant questions”.

Wisely, Cleeremans, Mudrik, and Seth instead focus on major theories of (what people mean when they say they are studying) consciousness. I found the authors’ summary and review of four major theories of consciousness, their unique claims, and empirical support for each particularly helpful. The nuanced consideration regarding what aspects of consciousness each theory addressed was also welcome. Both the novice and the “consciousness expert” can come away from the descriptions of global workspace theory, higher-order theory, integrated information theory, and predictive processing theory with a clear understanding of the claims and caveats associated with each.

The authors lament that “consciousness science remains somewhat marginal relative to the wider ecosystem of neuroscience and cognitive science [...] much research on behavioral control and decision-making has proceeded without heeding consciousness as a variable [...] the key concepts of feeling, reward, value, valence, and utility have been approached differently in different fields and have seldom been connected with consciousness research” (1). While it is true that only a small fraction of the broader field explicitly engages in consciousness research, it could reasonably be argued that almost everything in cognitive neuroscience can be recast as such. Vision scientists routinely conduct behavioral tests of what participants (consciously) perceive. Memory researchers probe their subjects’ (conscious) recollection. Attention researchers encourage their study participants to (consciously) focus on specific stimulus features. As such, one might view the marginal status of consciousness science as something of an issue of branding. Indeed, consciousness researchers may in some instances be able to meta-analytically mine the larger body of cognitive neuroscience research to see if some key open questions can be addressed with already existing data. After all, a research study need not be framed as “consciousness research” for it to meaningfully contribute to this field.

Predictive (and recurrent) processing theory, one of the four theories reviewed, is described as “not primarily a theory of consciousness but rather a general theory of brain function—of perception, cognition, and action” (1). This further highlights my contention that relevant work from the broader field of cognitive neuroscience can be brought to bear on issues of consciousness. Additionally, I was somewhat surprised to see very little discussion of split-brain patients by Cleeremans, Mudrik, and Seth in their lead article. Roger Sperry, who won the Nobel prize in medicine for his work on these patients, famously contended “among the most significant symptoms [...] was an apparent doubling in most realms of conscious awareness [...] each hemisphere seemed to have its own separate and private sensations, perceptions, concepts, and impulses to act, with related volitional, cognitive, and learning experiences [...] observations led to the opinion that the minor

hemisphere constitutes a second conscious entity that is characteristically human and runs along in parallel with the more dominant stream of consciousness in the major hemisphere” (2). To me, the split-brain phenomenon holds many provocative answers to the question of what it takes to support consciousness. How do Sperry’s observations square with global neuronal workspace theory, which posits that conscious processing relies on recurrent loops between distributed processors in the brain? Are two separate and independent global neuronal workspaces operating in the two disconnected hemispheres of a split-brain patient, potentially giving rise to two separate consciousnesses? What about hemispherectomy patients, who also clearly have conscious experiences despite having only one functional hemisphere (3)? These clinical observations suggest that one half of the brain is sufficient to support consciousness and might reasonably be used to adjudicate between theories of consciousness that link to specific neural substrates and processes.

As someone who has been peripherally involved in consciousness research, I was heartened to see the enormous progress in the field over the past 20 years. I am particularly impressed by the Consciousness Theories Studies (ConTraSt; <https://contrastdb.tau.ac.il>) database that has quantified the differences in the amount of research relating to the four theories of consciousness (4). This detailed documentation of how empirical results align with the predictions of different theories is a welcome move toward improving reproducibility and transparency. It is also great to see the increasing emphasis on adversarial collaboration to test multiple theories of consciousness simultaneously.

In addressing some of the conceptual and practical issues that hinder progress for the field of consciousness research, I am reminded of the important role of societies in establishing guidelines for a field that has not yet converged on best practices. For example, the Organization for Human Brain Mapping has endorsed a number of expert-driven committees that have tackled thorny issues such as best practices in data analysis and sharing (5) and on large-scale brain network nomenclature (6). The Association for the Scientific Study of Consciousness might be interested in supporting similar committees that work toward building consensus around better defining explanatory targets in consciousness research, for example.

One point that Cleeremans, Mudrik, and Seth argue throughout is that a greater focus on the phenomenological, experiential aspects of consciousness is needed (1). At the same time, they acknowledge that we lack a way to directly test for this aspect of consciousness in other species. As they discuss, “the world looks [...] very different to a fly than it does to us: each organism is sensing its environment through sensory modalities that have been shaped by different evolutionary constraints and hence yield conscious experiences that are markedly different”. This point is again alluded to in discussion of artificial systems: “[...] we humans might not be able to recognize—or have any relevant intuitions about—artificial consciousness or its qualitative character”. This leaves us with a dilemma when trying to move toward understanding phenomenal

experience or the *feeling* of something. Here I would argue that since we cannot reliably test other species, why not admit that we can only really explain *human* phenomenal consciousness, leaving aside for now the question of “what an experience is like for an organism”. We can best collect data regarding what an experience is like for a human through verbal self-report. What it is like to be some other non-human organism, biological or otherwise, is a separate question. I would go so far as to argue that we (humans) cannot know what it is like to be an organism other than human. Note that this argument is not stating that only humans have consciousness, but rather we (humans) can only know what it is like to be a (conscious) human. Of all the aspects of consciousness discussed, the phenomenological aspects seem to be the hardest area to gain traction. Perhaps the field would be best served by explicitly acknowledging which problems of consciousness (e.g., phenomenal consciousness in non-humans) might never be solved.

Speaking of human consciousness, because I am a conscious human, I am increasingly aware of certain bodily states indicating that it is time for me to take a break (a grumbling in the stomach indicating hunger, a slight pain in the foot that underwent surgery earlier, and a growing drowsiness caused by waking up too early this morning). As both my levels of consciousness and the content of my consciousness preclude further speculation, this seems an appropriate place to end my thoughts. As Cleeremans, Mudrik, and Seth remind us, the clinical, legal, and ethical implications of continued progress in consciousness research are many. Fortunately, the field is in good hands.

Statements

Author contributions

LQU: Conceptualization, Project administration, Resources, Writing – original draft, Writing – review & editing.

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