Title
Computation, perception, and mind

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Abstract

Advances in the behavioral and brain sciences have engendered wide ranging efforts to help understand consciousness. The target article suggests that abstract computational models (like IIT) are ill-advised. This commentary broadens the discussion to include mysteries of subjective experience that are *inconsistent* with current neuroscience. It also discusses progress being made through demystifying specific cases and pursuing evolutionary considerations.

Main Text

The target article proposes that IIT, a computational formalism, is “A case of mistaken identity”. I concur and further suggest that the failure of the IIT identity assumption is an instance of a deeper problem, the widespread focus on computational models of the mind that are independent of both neural structure and subjective experience (Melloni 2021). The target article’s main suggestion, better formalisms, does not help much, but their proposed re-orientation to constitutive questions would be a major advance. An excellent new review of historical and ongoing attempts to explain the experience of the mind is (Cobb) 2020).

The ancient mind-body problem manifests in everyday experience. As one example consider the text below:

U Q C G O + C O U Q G

Close or cover one eye, focus on the +, and try to read the letters to the left. You will find it much easier to read the letters on the right. Neural encoding of fine detail is restricted to the fovea, covering about the size of your thumbnail at arms-length. Our experience of a stable high-resolution scene is i*nconsistent* with conventional science of the visual system, as well as any proposed alternative (Feldman 2012). A related phenomenon, the experience of a visual ego-center, is discussed in the target article. There are myriad other inconsistency examples. If you touch your nose with your thumb, the contact feels simultaneous despite the large difference in neural conduction times.

The target article and IIT are part of the scientific approach to the mind-body problem and consciousness. Philosophers march to a different drummer, but both would be well served by recognizing the fundamental mysteries of mind.

“The most beautiful and profound experience is the feeling of mystery. It underlies religion as well as all deeper aspirations in art and science.’ Einstein”
No one has proposed a physical explanation for the i*nconsistency* of neuroscience and much subjective experience and this is seldom acknowledged.

Some investigators, foregoing grand theories of consciousness, are pursuing two productive scientific approaches to these mysteries: demystification and evolution. Much scientific progress is demystification, often involving inconsistency of theories and findings. One current mental demystification involves blindsight (Fox 2020), until recently considered a major mystery. People with certain deficits are unable to report what they see, but can carry out appropriate actions like grasping a tool. In retrospect, the mystery of blindsight arose from the simplistic assumption that visual perception was a single integrated function. Actually, there are several interconnected vision networks, including some, like reflexes, that do not require conscious perception. The exploration of multiple visual systems is also having clinical applications (Fox) 2020). Extending this hybrid approach, an ambitious going project (Hesse 2020) incorporates a wide range of experimental and computational methods in revealing aspects of face perception in people and other primates.

Any physicalist explanation of the mind will need to incorporate an evolutionary story (Feldman 2020). There are already useful studies of possible precursors of human consciousness (Merker 2007). These employ the modern eco-evo-devo formulation of evolution. All creatures need to incorporate a notion of *valenc*e, sensing what is good and bad for the creature. One informative example is the color constancy of the Hawkmoth (Balkenius 2004). These moths recognize the same flower color under changing illumination conditions. This ability is especially important for foragers that are active under a range of lighting conditions. Receptor adaptation contributes a large part to color constancy; the sensitivity of specific receptors decreases as a result of adaptation of the photoreceptor cells being stimulated by the background illumination. Importantly, color constancy evolved by natural selection; moths with better vision tend to prosper. No learning by the moth is needed.

The moth story suggests a general explanation for the adaptive utility of subjective experience. The role of perception is to guide action and, in more complex creatures, memory and planning (simulation). Successful action requires percepts that capture relevant aspects of the environment (umwelt), like the color of flowers for the moth. In the human case, there need to be *actionable* internal representations of the external physical and social world. In many cases, like my examples above, we also know that the actionable information is not captured by our sensors and is also not encodable as conventional neural systems (Feldman 2012). Informal experiments as well as intuition show that the information captured by our sensors and expressed in the known brain circuits does not suffice for human functioning. One mystery is how the ecologically required information is represented in the brain. A further mystery is how we come to be aware of (some of) this information.

In a few remarkable cases (Iriki 2012), we also know the neural correlates of the embodied experience of external objects like the blind man's cane. For many years, tool embodiment was treated as a deep mystery (Pazzaglia 2020). In a 1996 experiment, Iriki et al. trained macaque monkeys to retrieve distant food using a rake, and recorded neuronal activity in the caudal postcentral gyrus where the somatosensory and visual signals converge (Iriki 1996). There they found a large number of bimodal neurons, which appeared to code the body schema of the hand. After extensive tool use, the visual receptive fields of these cells adapted to include the entire length of the rake or cover the expanded accessible space.

Subsequent developments have included attempts to improve human prostheses by generating this kind of subjective embodiment (D'Anna 2019). With training, people can improve performance by developing direct embodiment of a prosthetic arm with indirect feedback or, better, with direct connection to appropriate nerves. Of course, the *mechanism* of subjective experience is still unknown.

The many remaining mysteries of consciousness strongly suggest that any reductionist solution of the mind-body will require scientific reconceptualization on the scale of general relativity or quantum theory.

Both of these groundbreaking theories are famously unintuitive and any physical explanation of consciousness, if one is discovered, may well be equally challenging.

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