Sentience in all organisms with centralized nervous systems

Commentary on **Mikhalevich & Powell** on *Invertebrate Minds*

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Abstract: Mikhalevich & Powell (2020) argue for considering the welfare of invertebrates, especially insects, by asking whether invertebrates have the cognitive and neural characteristics necessary for sentience. This approach assumes that human neural and cognitive complexity is the basis of sentience. But insight might also be gained by turning this approach on its head and examining the notion that sentience may be a fundamental biological property, appearing very early in the evolution of life in all organisms with centralized nervous systems.

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Mikhalevich & Powell (2020) (M&P) are to be commended for bringing the long-neglected issue of invertebrate ethics to the forefront in an incisive and well-researched target article. As they point out, although increasing attention is being paid to ethics concerning some invertebrate groups (such as cephalopods; Jacquet et al., 2019; Mather, 2019; King & Marino, 2019), others, such as insects, are typically denied consideration despite comparable evidence for sentience. M&P make the case for extending welfare protection to invertebrates, especially insects. They focus on a variety of variables such as brain complexity, cognitive capacity, and sentience.

The "down from humans" approach. We typically view sentience ("something it is like to be") (Nagel, 1974) as a property of human brains and then we inquire what other species have it. M&P point out that this approach is problematic because it takes the human species as the gold standard for a phenomenon we do not yet understand. They note that it is difficult to identify the "neuro-computational threshold(s)" that divide those species with the ability to suffer — who hence deserve moral consideration — from those who do not. Although M&P consider that the requisite qualities for moral consideration may be a matter of degree rather than all-or-none, their analysis takes the usual downward trajectory on the *scala naturae*, asking how "low" we can go and still find species with cognitive features we consider important for moral consideration.

M&P dismiss homology-based strategies for extending recognition to invertebrates, pointing out that invertebrate brains evolved largely "independently from vertebrates,"

considering the evolutionary distance of the last ancestor between them: "homologies at lower levels, such as cell type and signaling molecules … do not have any straightforward implications for sentience or cognitive sophistication." But what if we have it upside down? What if sentience is the most basic feature of all organisms with central nervous systems? If sentience appeared very early in the evolution of nervous systems, then all brains are simply different versions of the same basic process. In that case, the complexities we recognize in mammalian, primate, and human cognition are not what afforded the ability to feel and therefore have welfare.

To be clear, I am not making an argument for the Cellular Basis of Consciousness (CBC) (Reber, 2016) or panpsychism (Goff, 2017). While there are many basic elements of information processing in single cells that appear to have been co-opted during the evolution of multicellular animals, there are also many important empirical criteria that have not yet been met for acceptance of either notion. However, staying within an empirically sound and materialist framework, the recognition of neural, functional, and evolutionary continuity may also indicate shared cognition and sentience across a much greater range of organisms.

Evidence for the primacy of sentience. Several authors have suggested, based on both homology and analogy, that continuity at the neurophysiological level reflects continuity at higher levels of brain organization. Basic processes associated with neural transmission may set the stage for sentience without entailing that all organisms or all objects are sentient (Braun, 2015; Klein & Baron, 2016; Marino, 2015).

Cook, Carvalho, & Damasio (2014), for example, reason that electrostatic changes associated with neuronal action potentials underlie "sentience" at the cellular level and that the coordination of these processes may have led to the emergence of organism-level awareness or sentience. They do not make any claims about subjective experience in single-celled organisms, noting only the continuity in neurophysiological mechanisms and function (to maintain homeostasis) shared among protozoans and metazoans.

Lane (2009) has also noted that "consciousness, at bottom, is about life and death, and not about the wonderful pinnacles of the human mind" (p. 259). In other words, sentience may be primal; more complex vertebrate brain structures may simply change the content or increase the range of features in the world we are aware of, but they are not necessary for basic subjective experience.

Tononi & Koch (2015) have formulated a model called Integrated Information Theory (ITT), according to which consciousness is a fundamental property of all systems that have certain cause-and-effect features. They argue that consciousness is graded and can be found in the simplest of organisms as long as they have these features. They do not imply that conscious experience is equivalent across organisms but only that possessing consciousness – or sentience, if you will — can be a property of even very small brains.

Are invertebrate and vertebrate brains really all that different? M&P suggest that invertebrate and vertebrate brains are so disparate that comparisons are not useful. But how different are the brains of arthropods and vertebrates? Bilaterians emerged in the fossil record about 550 to 600 million years ago as early wormlike creatures with a nerve cord running down their body and enlarged ganglia (early brain) at the head region. This process is called cephalization; an anterior

brain connected to a nerve cord became the Bauplan of the nervous system thereafter for all organisms with a central nervous system (Arendt et al., 2008; Striedter, 2005).

Both invertebrate and vertebrate brains rely on the same basic principles of information processing. All of the major vertebrate neurotransmitters, which are ultimately derived from single amino acids, are also found in invertebrate brains (Messenger, 1996), and most of them also served as signaling molecules before the first central nervous system evolved (Turlejski, 1996). Moreover, embryonic development of nervous systems across species reveals a highly conserved plan (Striedter, 2005). Others have pointed out that there are key functional similarities between insect and vertebrate brains (Klein & Baron, 2016). Strausfeld & Hirth (2013), for example, have argued for a deep homology — not just analogy — between some insect and vertebrate brain structures.

Conclusion. If sentience is a fundamental property of all organisms with brains, then vertebrate and mammalian brain structures are not the critical ones for sentience, hence ethical consideration. It exceeds the scope of a commentary to review and evaluate the evidence for this hypothesis, but it would be important to subject it to rigorous empirical examination.

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