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Disentangling sentience from developmental plasticity

Commentary on **Segundo-Ortiz & Calvo** on *Plant Sentience*

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Abstract: Plants, like animals, display remarkable developmental plasticity, inviting the metaphorical use of terms like “decision” and “choice”. In the animal case, this is not taken to be evidence of sentience, because sentience is a complex product of development, not something that guides it. We should apply the same standards when evaluating the evidence in plants. It is hard to overstate the contrast with the case of invertebrates such as octopuses, where pain markers that were originally developed for use in mammals have been clearly demonstrated and plausible neural substrates for sentience have been identified.

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Segundo-Ortin & Calvo (2023) have a modest aim: to convince us that the possibility of plant sentience is "worth exploring scientifically". Although they grant that "more detailed knowledge of plant behaviors is needed before we can make any confident claims about whether they are sentient", they caution against "concluding that plants are not sentient because they lack brains".

It is hard to tell whether they see the evidence they cite as raising the probability of sentience. In my view, it does not. I think (i) it is fair to be initially very sceptical of the idea of plant sentience, and (ii) evidence obtained so far has not given us grounds to revise the probability upwards, but (iii) careful attempts to obtain new evidence are welcome. I hope that Segundo-Ortin & Calvo, in their responses, can state whether they agree. If they disagree, I hope they can state which parts they disagree with.

A point of agreement: there is abundant evidence of remarkable developmental plasticity in plants (West-Eberhard 2003). Watching a bean shoot develop in time-lapse is fascinating and spectacular. Likewise, there is remarkable developmental plasticity in animals, and watching any animal embryo develop in time-lapse is fascinating and spectacular. It is an astonishing feat of chemical and bioelectric signalling, coordination, and differential gene expression (Levin 2021). It is very natural to talk metaphorically of an animal or plant making “decisions” or “choices” as it develops.

In the animal case, however, it is generally accepted that developmental plasticity is not evidence of sentience. If a review of evidence of sentience in an animal taxon (e.g. Crump et al. 2022 on decapod crustaceans) had presented copious evidence of developmental plasticity, the commentaries would have rightly dismissed this evidence as irrelevant. Discovering that animals of a given clade (placozoans, for example) display impressive plasticity does not raise the probability that they are sentient.

This is because, in the animal case, we know that sentience is a complex product of development, not something that guides it. Granted, humans have created rare exceptions: we can consciously choose to take drugs such as testosterone that will affect our developmental trajectory. But these are exceptions that prove the rule, as it were, because it takes all of our technological ingenuity to exert the tiniest degree of influence. Animal development is not normally guided by conscious choice.

So, the path to seeing plasticity as evidence of sentience requires us to set aside one of the most basic, most fundamental pieces of common ground in animal sentience research. We are being asked to take seriously the possibility that, while sentience has no role in guiding development in animals, sentience in plants does have this role.

It is not easy to get a science going when it is founded on such an extraordinary speculation. Suppose I were to make an analogous speculation concerning animals. That is: imagine I propose that, in animals, developmental plasticity should be taken as evidence of a second, mysterious, hitherto unnoticed form of sentience, one that requires no neural basis and is already at work early in embryonic development before the central nervous system has developed. Too speculative? People entertaining the idea of plant sentience should feel pressure towards consistency here. If you find it just too much to speculate about this second form of sentience guiding the development of embryos, consistency suggests you should also regard the parallel speculation about plants as too much.

What is the difference with the case of invertebrates? Some may say: isn't that also a research program founded on speculation? You are speculating that a capacity that involves the neocortex in mammals can also exist without the neocortex. Why is that any different? I see two major differences.

One is that we can directly apply experimental approaches used to assess pain in mammals, such as conditioned place preference tests, and observe behaviour that, if the animal were a mammal, these tests would clearly indicate pain (Crook 2021). When octopuses scrape at the site of a noxious stimulus with their beak, tend the area with their other arms, become averse to a chamber where they have experienced the stimulus's effects, and come to prefer a chamber where they experienced the effects of a local anaesthetic, it becomes very difficult—indeed, reckless—to confidently dismiss the possibility of pain. This leads to a challenge for plant sentience researchers: if you can demonstrate conditioned place preference akin to that seen in octopuses, many of us will have our confidence shaken.

The second big difference is that we know that in cephalopod molluscs, decapod crustaceans and insects there are brain mechanisms functionally similar to those of the vertebrate midbrain. It is reasonable (if unorthodox) to theorize, based on the mammalian evidence, that these mechanisms may be minimally sufficient for sentience in mammals (Klein & Barron 2016; Panksepp 1998; Merker 2007; Solms 2021). So, a potential neural substrate for sentience in invertebrates has been identified. But there are no such mechanisms in plants. No brain, no brainstem, no midbrain, and nothing analogous to these. Again, there is an implicit challenge for "plant sentience" researchers: show that the conditions described by Merker and Panksepp are satisfied by plants.

One of the pitfalls of speculation about plant sentience is that it can lead some commentators to draw false equivalences between plants and invertebrates. But the idea of such an equivalence does not survive a close encounter with the evidence from octopuses, decapod crustaceans or insects.

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