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Plant sentience: Getting to the roots of the problem

Commentary on [Segundo-Ortin & Calvo](#) on *Plant Sentience*

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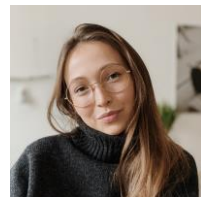
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Abstract: Segundo-Ortin's (2023) target article invites us to consider the possibility that plants can experience subjectively felt states. We discuss this speculation on the basis of the functional neurobiology of consciousness. We suggest that demonstrating plant sentience would require that we identify not only behaviors analogous to those exhibited by sentient creatures, but also the functional analogues of the mechanisms causing such behaviors. The lack of clear evidence for any kind of integration between self-states, self-movement, environmental states, memory, or affective communication within plants suggests that plant sentience remains an admittedly fascinating, but ultimately merely provocative speculation.

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Segundo-Ortin & Calvo (henceforth S&C) present a thought-provoking review of the current literature on plant cognitive capacities. We agree that some of their evidence lends some credibility to the claim that at least some species of plants may have behavioral capacities that are explicable as (modest) cognitive abilities. However, even accepting this weaker claim (for the sake of argument) would not in itself lend credibility to the much more contentious hypothesis that plants might be sentient.

The bulk of S&C's argument rests on evidence of similarities between animal and plant behavior. It is indeed genuinely fascinating to realize, for example, that once sped-up, plant behavior can sometimes appear to reflect the kind of intentionality more typically associated with animals; and that plants appear capable of sophisticated forms of communication. S&C rightly point out that engaging in this kind of analogical reasoning is one of the main research

methods in animal cognition. However, this methodology is not sufficient to establish sentience, for two interrelated reasons:

(1) To argue in favor of ascribing sentience, or any other cognitive capacity, on the basis of behavior requires that one first identify a set of dispositions and reactions that can serve as strong predictors of the capacity of interest (here sentience) in one species. Then one must demonstrate their presence in another species.

(2) However, since many of the behaviors associated with cognitive capacities in humans and higher mammals can be carried out unconsciously, observing similarities in behavioral responses alone does not provide enough evidence for the presence of subjective experience. This is why some researchers have advocated moving beyond mere behavioral analogies to finding similarities between the mechanisms responsible for such behaviors in different species.

As the details of biological implementation can differ between species, such mechanisms need to be distinguished primarily in terms of their causal-functional organization. This calls for specifying the range of functions necessary for sentience, which is why any search for a cross-species mechanism of sentience will depend on the crucial step of identifying some set of behavioral predictors of sentience. Unfortunately, S&C's evidence and arguments fail to overcome either of these hurdles.

S&C are right that there is no consensus about which biological features are necessary or sufficient for sentience, yet there are many viable proposals as to which kinds of behaviors and cognitive capacities might be used as reliable predictors of sentience. Not only do S&C fail to evaluate their own evidence in terms of these proposed predictors of sentience in animals, but very few (if any) of the plant behavioral capacities that S&C do cite have been previously taken to be indicative of sentience (e.g., Smith & Boyd, 1991; Sneddon et al., 2014; Crump et al. 2022; Solms, 2022). For example, in their recently proposed framework for studying sentience in decapod crustaceans, Crump et al. (see also Birch, 2023) point out eight capacities, and propose that the presence of three or more of them substantially increases the probability of sentience. Nearly all these capacities are linked with responding to or avoiding noxious stimuli. The ability of plants to produce endogenous chemical compounds that may play the role of anesthetics, as well as plants' susceptibility to general anesthesia come closest to satisfying one of the Crump et al.'s criteria (specifically, analgesia), but this is clearly not enough for inferring that plant behaviors are driven by felt states. To see why this is the case, we need to look beyond mere behavioral analogies and focus on the functional mechanisms potentially responsible for plant sentience.

S&C do cite the work of Klein & Barron (2016) to point out that the functions responsible for the emergence of sentience are likely to be multiply realizable, but they fail to appreciate the importance of the fact that Klein & Barron's argument in favor of insect sentience starts with identifying a minimal model of the neural mechanisms required for sentience in the vertebrate midbrain and only then proceeds with identifying mechanisms that play functionally analogous roles in the insect encephalic ganglion. This minimal model builds on the work of McHaffie et al. (2005), Merker (2007), Damasio & Carvalho (2013) and others in the assumption that sentience results from an integrative process that enables autonomous animal decision-making by bringing together information about the animal's self-state, endogenously generated movement, environmental conditions, and memory of previous experiences. Although some of the research cited by S&C does demonstrate low level capacities for memory and multi-source stimulus integration, there is very little discussion of evidence in favor of causal mechanism(s) that could play the integrative role

described by Barron & Klein's minimal model. Evidence from 'plant neurobiology' is mostly restricted to similarities on the cellular level. There is no indication of physical structures that could interact causally in a way that would offer multi-scale integration between diverse cognitive capacities (see also Pessoa's [2023] commentary on the absence of functional centralization in plants). The evidence of plant susceptibility to general anesthesia is an illustrative example, as this kind of intervention lacks the selectivity that is needed to distinguish between targeting the mechanism(s) responsible for sentience and disrupting all behavioral and cognitive capacities by knocking out low-level biophysical processes (see also Damasio & Damasio's [2023] commentary for a further discussion of this example).

In sum, S&C's proposal that plants might be sentient remains a purely philosophical conjecture. In order to even begin to properly evaluate this hypothesis empirically S&C would have to choose a set of behavioral criteria that are likely indicators of sentience in humans and other animals, to specify the range of functions underpinning such behaviors, and to identify possible causal mechanisms for implementing those functions. Only then could they look for causal-functional analogues in plants. Since none of these steps have been completed, the claim that plants might be sentient currently lacks credibility.

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