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Plant sentience: Time scale matters

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

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Abstract: Segundo-Ortin & Calvo (2023) have made a valuable effort in directing the discussion about plant sentience toward a strict scientific path. However, scientific endeavors must reconcile with common sense beliefs. Although nowadays people tend to accept the idea of animal sentience, this is not easily extended to plants. One reason is the difference in time scale in which phenomena occur in plants and animals; but this still does not preclude the possibility, in principle, of plant sentience in a form difficult for us to imagine.

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In support of the rather heretical hypothesis of sentience in plants, Segundo-Ortin & Calvo (2023) (S&C) present well-focused evidence on plants' cognitive behavior and the ability to signal and integrate information. But scientific endeavors can encounter serious obstacles when they clash with a culture's cherished belief systems (Laudan 1977).

The beliefs that are probably most resistant to change in the face of new science are the ones about humans, especially the beliefs that give us the sense of being special in the world. Even today, there is still desperate resistance to the idea that we too are products of evolution by natural selection. We are too attached to the idea of complete free will to accept neural determinism. Gutfreund's (2023) commentary on the cultural aspect of the consciousness debate is pertinent. Even if one disagrees that sentience cannot be studied scientifically, cultural factors and scientific research are intimately intertwined. Consciousness in other animals was a hard-won concession, no doubt facilitated by the spread of humans' affectionate relationships with family animals. Extending such a concession to plants seems far from common sense. It is important to explore the reasons why.

One reason that makes it difficult to imagine something similar to their own phenomenal experience in a plant is the difference in timescales at which phenomena take place. For vision, the richest source of conscious experience in humans, the timing for information to become conscious is about 180 ms (Mai et al., 2019). At the whole-brain level, the typical time scale is of the same order of magnitude, about 150 ms (Kobeleva et al., 2021). As reported by S&C, two fundamental mechanisms for information signalling in plants are variation potentials (VPs) and system potentials (SPs). Their typical timescale is 5 to 20 minutes (Zimmermann & Mithofer, 2013). Shorter timescales, from 10 to 200 seconds, are those of the third and least common plant electrical signal: action potentials (APs). It is no surprise that the plants with behavior based on this relatively rapid signalling, such as *Dionaea muscipula* and *Mimosa pudica*, are the ones most often singled out as potentially sentient. Brain dynamics are still at least two orders of magnitude faster than AP signalling in plants, and three or four orders of magnitude faster than VP and SP. The challenge presented by the

difference in timescales between plants and animals has been acknowledged by both proponents (Reber & Baluška, 2021) and critics (Mallatt et al., 2021) of the hypothesis that plants are sentient. However, this issue has primarily been framed as a difficulty in applying animal-based models to plants, rather than as a cultural barrier to accepting the notion of plant sentience.

In science, timescale can be a dimension along which reality is partitioned into distinct categories of systems and phenomena (DiFrisco, 2017). The differences in signal timing for plants and humans are probably not enough to indicate two different classes of phenomena from a scientific point of view. After all, these differences vanish in the context of all scales of reality, from the average lifetime of a boson to that of black holes. By contrast, the difference between plant and human timescales for signalling becomes enormous in terms of our felt experience of time. Our felt unfolding of events and the passage of time is tied to the sampling and processing times of our brain. The central aspect of time in human consciousness was highlighted long ago by William James (1890) with the concept of the *stream of consciousness* and by Edmund Husserl (1893) with his *inner time consciousness*. Current neuroscience of consciousness is trying to relate the continuity we experience across time with the discontinuous processing of discrete neural events (Kent & Wittmann, 2021). It is impossible for us to imagine conscious experience in which the "atoms of thought" flow at a rate that is one-hundredth or one-thousandth of our own.

The gradual integration into our culture of scientific evidence of animal sentience has been facilitated by familiarity with our family animals (Nagasawa 2022). We easily perceive psychological states similar to our own in them, including the feeling of joy and pain (Keysers 2022). The natural tendency to anthropomorphize is systematically criticized when detected in scientific research, especially in the field of animal sentience, and now plant sentience. The error of anthropomorphism is pointed out in other commentaries on S&C's work (Robinson et al., 2023; Struik, 2023). Excessive reliance on anthropomorphism is certainly risky, and close to the romanticism that S&C wish to exclude from plant sentience research. However, the recent history of animal studies, including studies on sentience, reminds us how the attitude against anthropomorphism has been detrimental to progress. Forms of "constructive anthropomorphism" (Burghardt 2016, Arbilly & Lotem 2017) can offer valuable heuristics in the early stages of research, providing a temporary vocabulary and analogies useful in planning experiments and gaining understanding (Bruni et al., 2018). Anthropomorphism is certainly a tool that must be handled with care. The differences in timescale may confer some useful constraints on our imaginations. In extending the vocabulary of psychological and neural states from humans to plants, the timescale disparity would force us to keep in mind how profoundly different sentience would have to be, if it existed at all.

In a famous article, Nagel (1974) pointed out that a human cannot grasp what the subjective experience of bats, based on ultrasound echoes, feels like. Yet most of us believe bats are sentient. It would undoubtedly be even more challenging to imagine the subjective experience, if any, of a plant, whose perceived time would have to be hundreds of times slower than ours. Yet, in itself, even this would not preclude plant sentience, even if it felt far different from our own.

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