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Sentience: back to the science from the words

Comment on **Segundo-Ortin & Calvo** *Plant Sentience*

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Abstract: Contributors to this discussion acknowledge ambiguities in the terms used, including 'feelings', 'behavior', 'cognition' and 'sentience' itself. Yet they continue to use such words without reference to scientific criteria established by experimental psychology.

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The uses of words in science are not strictly specified until there is consensus among relevant experts on the empirical evidence for distinguishing their referents, such as "protons" vs. "electrons." The Editor helpfully lists key terms in the debate about sentience in plants and draws conceptual distinctions among them, allowing that some are fuzzy (Harnad 2023). Through appropriate experimental design, psychological science has made clear factual distinctions among phenomena variously claimed to relate to 'sentience'. Grounding discussion in agreed facts rather than disputed concepts would speed progress in collecting and interpreting relevant evidence from individual members of different species as well as human-engineered artifacts (Booth 2004).

The word 'feel' is ambiguous between the broad categories of sensation and affect – each diverse in its usage. 'Sensation' can refer to the processing of stimulation by the sensory organs and the brain as well as to the way people discuss this. 'Affect' can refer to emotions and moods but also to motives, intentions or purposes in actions. A 'feeling' might be both sensation and affect (such as in feeling comfortably or uncomfortably hot or cold), but the two should not be conflated. The boiling water in the pot is not feeling hot, reacting angrily or taking action for the cook, because it is not transforming informational content between input and output. There is just the agitation of atoms throughout.

More broadly, the words 'behaviour' and 'cognition' mean the same thing when expertly used. Information content is transformed from a selection among inputs into a choice among the options for output. Thus, behavior is not movements of the body, nor any sort of output observed without reference to the input that influences it. Cognition is not thought without content: there is output as well as input, along with the processing between them. Attention may be on output (decision making), input (perceiving) or the reasoned or reactive

transformation of input patterns into a momentary output pattern. Contrary to Harnad's distinctions 2 and 7, 'feeling something' is observable and measurable by analysing individual organisms' (and machines') output/input performance (e.g., Booth & Freeman 1993; Booth, Freeman, Konle et al. 2011).

First, behavioral-cognitive performance must be distinguished from mere physical causation by identifying inputs that account for each output. Then we may be able to measure a sophisticated interaction among input-output relationships that amounts to feeling something. Seeing a white patch surrounded by cyan green in an impressionist's painting feels like seeing red. The analogy holds: the felt red can be matched to an actual red patch, surrounded by gray (Booth 2003).

Unicellular organisms transfer specific stimuli into specific responses in taxes such as movement up a concentration gradient of a particular chemical compound. Plants show tropisms such as growth into light and against gravity. The bean shoot in Segundo-Ortin & Calvo's (2023) video might multiply cells at its tip and collapse randomly sideways when gravity overcomes turgor, without any external influence. Nevertheless, the shoot does bend towards a source of light. The same phototropic behavior occurs when the shoot tracks the movement of the sun across the sky. Yet the rotation through the full 360^{O} seen in the video requires additional input. Does the point of anchorage provide a stimulus that is transformed into rotation (in the same direction)? Then does the shoot's contact with the bean pole induce a bend or the rotation?

The crucial question is whether the bean shoot circling up the pole is a separately controlled response or it is fully explained by a combination of the simpler transformations of input into output. If quantitative modeling of the behavioral data shows that the shoot operates under a distinct construct of circling higher and higher up a stick, that could be a first step towards granting that the plant had some sort of implicit awareness of the bean pole.

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