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Cognition wars

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A B S T R A C T

In what kinds of physical systems can cognition be realized? There are currently competing answers among scientists and theorists of cognition. There are many plant scientists who maintain that cognition can be realized in plants. There are biological scientists who maintain that cognition is materially realized in bacteria. In this paper, I will present the basis for such claims and evaluate them and discuss the future for theories of the metaphysical basis of cognition in the cognitive sciences.

1. Introduction

In case you missed it, there is a war going on over what counts as cognition. Luckily, it is a war among academics, so likely no one will get hurt, but it is a war nonetheless. It started with challenges to the traditional conception of human cognition holding that cognition takes place in the brain after perception and before motor processing.[1] On the traditional view, perception was to get information into the brain, then concepts and reasoning take over, and finally the motor system is employed to do the mind's bidding. Embodied cognitivists have been challenging this view of cognition at least since the late 1990s and probably since long before among continental philosophers. On the embodied view, cognition literally takes place in, is realized in, the perceptual and motor systems. On the traditional view, that was never believed to be the case. On the embodied view, the body itself plays a much larger and more constitutive role in the realization of cognition than on the traditional view of cognition.[2]

The war spread to include theories of extended cognition. These theories claim that the boundary of the body and brain is an arbitrary one and there is no principled reason why cognition is not realized out into the environment in the form of perceptual-motor interaction, tool uses, and other forms of cognitive off-loading or scaffolding. This view too started in the late 1990s, but has continued to pick up steam ever since. On this view, cognition is not a process that is realized only inside the brain anymore (well, it never was really on this view, but this only became an issue recently).[3] So for example, if cognition extends, then physically rotating a jigsaw puzzle piece might count as a realization of cognizing. In addition, when using pencil and paper to do a long division problem, the manipulation of numerals on the paper would count as realization of cognizing (and not just an aid to cognizing) on the extended view.

Finally, plant scientists and bacteriologists (Ben-Jacob, 2009; Garzon & Keijzer, 2009; Garzon, 2007; Lyon & Keijzer, 2007; Trewavas, 2003) now are telling us that cognition is realized in plants and in bacteria.[4] As I have addressed the issues with respect to embodied and extended cognition before, in this paper I turn our attention to the claims that cognition is realized in plants and in bacteria. I hope to get to the bottom of this and understand why people are saying these things and to evaluate the plausibility of the claims.

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[1] See Adams (2010) and Larry Shapiro (2011) for a good overview of the issues surrounding embodied cognition.

[2] See Semin and Smith (2008) and deVega, Glenberg and Graesser, (2008).

[3] See Adams and Aizawa (2008), Rob Rupert (2009), and for an overview of the literature see Richard Menary (2012).

[4] See Garzon (2007), Garzon and Keijzer (2009), and Lyon and Keijzer (2007), Ben-Jacob (2009).

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2. Cognition in plants

Garzon (2007) attributes cognition to plants. On what basis does he attribute cognition to plants? He seems to think that plants engage in behavior that can only (or best) be explained by attribution of cognitive states. He says they "learn," "decide," "anticipate," and have "memory," among other cognitive states, but the basis for these attributions is the behavior that they display. What behavior? He discusses the behavior of leaf laimnas of Lavatera Cretica. It turns out that these plants orient their leaves at night in such a way that "anticipates" the future direction of the sun even over the course of several days without tracking the direction of the sun.

Garzon thinks this involves "computations" over "representations," and "off-line" processing. He claims that this "off-line" processing distances what plants do from mere "reactive" behavior. He suggests that the mechanisms by which plants do this involves circadian clocks not unlike the same mechanisms found in bees and other animals—mechanisms that point to shared forms of memory and learning across plant and animal kingdoms.

> "Reactive behavior differs from truly cognitive [behavior] because it fails to meet the principle of dissociation (the states of a reactive system covary continuously with external states). Off-line competencies thus mark the borderline between reactive, noncognitive, cases of covariation and the cognitive case of intentional systems. Nocturnal reorientation in *Lavatera cretica* leaves is not to be interpreted in reactive terms, since such a competency is not explained by means of online forms of covariation" (Garzon, 2007, p. 211).

Several important questions arise. When Garzon uses these cognitive terms to apply to plants, are they to be taken literally or metaphorically? If they are to be taken metaphorically, then there is no disagreement with traditional views of cognition. However, if they are to be taken literally, then there must be some shared core meaning of these terms as applied to plants and other cognitive systems such as animals and humans.

Not every plant scientist agrees about the literal use of cognitive terms by Trewavas (2004) and Garzon (2007). Firn (2004) thinks there are cases where the cognitive terms plant scientists use are misleading. With respect to Trewavas's use of "intelligence," Firn notes that the term derives from notions such as discerning, comprehending, and choosing. These activities, he says, require considerable mental processing of information "above the level of basic sensing" and he adds that there is little evidence that plants or plant cells do anything other than "rudimentary processing of sensed information." He says that this alone should caution one against using the term "intelligence" for the abilities of plants.

Garzon acknowledges that if one attributes cognition or computational states to plants, one must be prepared to find the mechanisms to support such attributions. But I would add that those mechanisms as well must share some similarities, if only in the ways in which they process information or the levels of information processed. I will explain this in due course, but consider just his use of the term "learning." When explaining so-called "learning" in plants, Garzon explains, "Plant genetics points towards underlying shared molecular components that explain day-length estimations and the operation of light receptors." Thus, the so-called learning that takes place in plants takes place at the genetic level. This seems quite different from learning in animals and humans that takes place in the course of a single lifetime and not at the genetic level.[5]

What is more, Firn (2004, p. 347) points out that were one to talk about a case of learning in plant root structure, if it turned out that when a root was exposed to an extreme gravitational stimulus twice and 12 h apart, the second stimulus would initiate a stimulation in cells that did not exist during the prior stimulation and, thus, could not have been learned. Again, the term "learn" cannot mean the same thing in the mouth of the plant scientist as it means when used by the animal-learning theorist. Firn contrasts animal learning where the learning resides at the level of the whole organism (as we would say, not the cell, and not the gene).

In addition, Garzon says he agrees with Firn that "any 'intelligence' that might be ascribed to 'the plant' could only reside in organs, tissues or cells because the concept of the plant as an individual is a misleading one. I agree with Firn that the concept of a plant as an individual is misleading …. "(p. 346). Once again, the notion that learning takes place in the tissues of a collection of individuals, not in a single individual, sounds like a different or metaphorical extension of the concept of learning.[6]

About a claim Trewavas makes that plants make decisions and choices, Firn (2004, p. 347) asks "Can plants really make choices in any meaningful way?" In remarks similar to his earlier ones, he answers that what Trewavas is calling choices are events happening at the level of the organ or cell, not even at the level of the whole plant. In animals that make choices, it is the animal who chooses, not its cells or organs. Firn adds that in two-state event types like flowering (versus not flowering) in plants, "the plant does not make a choice to flower" (p. 348). Instead, there are predetermined events in a leaf that determine the unfolding of flowering from some cells in the apex. Indeed, Firn thinks that taking cognitive terms normally applied to animals to describe plant behavior distracts from the key adaptive behavior in organisms that have evolved and "not been selected to learn, memorize, or think." In his view, the behavior described by Trewavas[7] and others is "best considered to be the sum collective adaptive responses of cells (Firn, 204, p. 349).

Garzon also goes to some length to support his claim that plants "compute" and that they compute over "representations." However, even if we are willing to be somewhat generous about what counts as computing[8] in plants and what counts as representations, these two facts would still fall significantly short of establishing that there is cognition in plants. For not every system engaging in computations on representations is a cognitive system. The computer on which this paper is being produced performs computations upon representations, but it is hardly a cognitive system. Clearly, something more must be going on in cognitive systems and it is not clear that Garzon has established that plants have that something more.

[5] Indeed, for many the difference between responsive changes to the environment due solely to changes at the genetic level, so-called "developmental explanations," versus changes within the organism's lifetime, genuine learning, is central to understanding cognition (Dretske, 1988, chapter 4).

[6] To be fair, Garzon argues that even in humans learning takes place in the neural connections below the level of the whole individual. However, I still think that there is an important difference in that, for humans and animals, there is a whole individual who learns. He also thinks that humans like plants are "coupled" to their environment making the locus of learning extended beyond the individual. Elsewhere (Adams & Aizawa, 2008) I have dealt with the fallacy behind this reasoning—the so-called "coupling/constitution" fallacy.

[7] In fairness to Trewavas, he gives a long point/counterpoint response to Firn (Trewavas, 2004), but we will cover many of his points in addressing Lyon and Keijzer (2007) in what follows. The real issue is whether he needs cognitive terms to describe and explain what plants do.

[8] For qualifications on what counts as a computation see Chalmers (1996).

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