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Making decisions does not suffice for minimal cognition

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In the early nineties, I stumbled upon Beer's *Intelligence as adaptive behavior* and I have been a fan of his work ever since. Beer has been one of the major players in developing a radical embodied, situated and dynamical perspective on cognition. In this radical perspective, the reciprocal relation between perception and action becomes the primary concern for cognitive theorizing, while the relevance of computation and representation for cognition are questioned. The radical perspective remains very controversial, and one of the major issues on which it is questioned is the cognitive status of basic perception-action couplings. This reaction can go as follows: Perception-action coupling is definitely important for on-line problem solving and action, but *thinking*, being the prime example of cognition, is something that we do best off-line, preferably reclining in a chair (e.g. Clark, 1997; Grush, 2003; Wilson, 2002). Thus, the more traditional interpretation holds that the radical embodied perspective overstates the importance of perception-action coupling as the notion of cognition itself remains unaffected. How to proceed with this debate?

Beer's paper aims to contribute to this debate by the careful study of "idealized models of *minimally cognitive behavior*" in order to "improve our intuitions, clarify the key issues and sharpen the debate" [p.4]. However, I doubt whether Beer's present study will significantly clarify the issues at stake in the debate about the radical embodied view. In my view, he leaves unclear a key issue in the debate: *What do we consider cognition to be?* Both parties answer this question differently.

The radical embodied view stresses the primacy of physical organism-environment couplings by means of which problems—moving about, feeding, avoiding predators, and so on—can be solved in the actual world. In this view, any system capable of performing such feats of behavior is simply a cognitive system. In contrast, more traditional views stress a capacity for problem solving as the key ingredient of cognition. These problems can range from tasks derived from biology (e.g. sex-ratio decisions in parasitic wasps) to abstract reasoning (e.g. deciding on the next move in a chess match), as long as it involves making a decision that solves the problem in an intelligent (adaptive or rational) way. What counts here is the decision making process. In the traditional view, the physical execution of those decisions is not at the heart of cognition, but assumed to occur in addition to making the proper decisions.

Beer's choice of categorical perception as an example of minimally cognitive behavior, aims to engage a traditional cognitive task in an embodied, situated and dynamical treatment, showing how the latter can deal with the former. But while the execution of this case study is ingenious and insightful, it does not do the conceptual

work that is necessary in the debate between radical and more traditional interpretations of embodied cognition. For the non-radicals, I suppose that the case will be too minimal. Beer's case study does not address genuine representation-hungry problems that definitely require off-line processing (Clark, 1997; Grush, 2003). Beer himself admits this in the paper. However, I want to argue that there is a less obvious problem for this case study: Beer's model of categorical perception does not suffice as an example of the radical embodied view on cognition either.

Returning to the different criteria for deciding on what we consider as cognition, categorical perception clearly falls under cognition when the decision-making aspect of cognition is stressed. But, I hold, his model falls short of being a minimally cognitive behavior under the radical embodied criterion of involving physical agent-environment couplings. Before turning to the motivation for this claim, I want to stress that this point does not hinge on Beer's model being a simulation rather than a physical robot. The point focuses on the criteria that are being used for categorizing something as an agent. These criteria can, in principle, be accommodated in a simulation, but I will argue that this has not happened in the present case.

What would be considered a *minimally cognitive behavior* from a radical embodied perspective? I find this a difficult question that has, as yet, no clear answer. If the presence of perception-action couplings between an agent and its environment is taken as a criterion, a problem arises for what we consider as agents, and tied to this perception and action. The problem is highly similar to the symbol grounding problem. It is easy to ascribe meaning to the elements of a symbol system, but how does such a system acquire meaning on its own? Similarly, there is what might be called an *agent ascription* problem, which centers on the question when such an ascription is more than just that, an ascription. Would a thermostat suffice? What about Van Gelder's example of the Watt governor, or more to the point, Beer's present model agent? In these cases, it is easy to designate these systems as an 'agent' but much more difficult to formulate why this predicate would be appropriate rather than arbitrary.

What I find a productive way of addressing this issue is by first restricting it to biological agents. Within the living world, there are many uncontested examples of agents, ranging widely in their behavioral capabilities. What would a minimally cognitive behavior be under this biological constraint? Even now, the question remains difficult to answer, as the notion of perception-action couplings seems to apply to any free moving organism, whether these are bacteria, protists, or animals. Luckily, nothing much hangs on where exactly we draw the line for a minimal agent. Even for unicellular organisms, there is a lot of complexity involved. Whether it be a cellular surface covered by cilia that beat in a coordinated way, or a single, much larger flagellum that whorls and so produces forward movement, it will consist of a coordinated form of mass action involving large portions of the organism that together results in movement, change of direction, ingestion or other behavioral capacities. For examples see Brusca and Brusca (1990). The same principle holds even stronger for the coordinated whole body-movements of the most basic animals with a nervous system, such as cnidaria, comb jellies, and flatworms (ibid.). The lesson here, it seems, is that dynamical perception-action couplings never come alone. You can't have an agent with a single perception-action capacity, without it stopping being an agent. It will lack the characteristics for its continued existence as an agent. Being an agent, or agency, is much like the notion of *metabolism*. Metabolism also consists of a collection of interconnected and coordinated processes. None of those individual processes does itself form a metabolism. One can study each individual process as a

metabolic pathway, but its metabolic role only applies within the context of a particular metabolism. There is much more to defining minimal agency that I cannot go into here (Keijzer, 2001). But the present point drawn from biology is straightforward—although highly controversial: An agent that can do only one thing is not an agent.

When the criterion for agency within the radical embodied view on cognition consists of the presence of an unspecified, but significantly large number of perception-action capabilities, Beer's agent, capable of moving left and right in a one-dimensional world, does not pass the test for minimal agency, or minimally cognitive behavior. Beer's model is an agent only because it is designated as such. I must stress that this particular interpretation of the radical embodied view is my own view and not necessarily shared by other sympathizers of the radical view (Keijzer, 1998). Beer is certainly not alone in working with what is here argued to be a too limited notion of agents. The view presented here is the controversial one.

Accepting for the moment the conclusion that Beer's categorical perception model does not count as minimally cognitive behavior, what are the implications? These go in two directions. On the dynamical modeling side, it does not matter very much. Beer's analysis of the coupling between an 'agent' and its environment remains an impressive case study of a dynamical systems approach to intelligent behavior. To return to the metabolism analogy, the study of particular metabolic pathways is essential for understanding the characteristics of a metabolic system. For this purpose, it is completely irrelevant that a modeled pathway is not a model of the metabolism itself. However, when it comes to the clarifying conceptual work that Beer's case study is supposed to do, the same analogy points to more serious implications: What we need here is an explication and defense of the claim that we need to think of the whole system in terms of a metabolism, rather than anything else.

Beer's case study will be insufficient for a substantial clarification of the conceptual issues involved in the debate on radical embodied cognition. We can now see the problem comes from both sides. As his case study does not address representation-hungry problems, proponents of a more traditional view will not easily be convinced that their problems are sufficiently addressed. But, Beer's case study also misses an essential part of the message put forward by a radical embodied view: a different view on what we take cognition to be. The radical claim is that not intelligent decision making is the key issue of cognition, but organism-environment coupling through perception and action. Beer's example relies on the traditional decision criterion for cognition while he neglects the radical perception-action criterion, as filled in by biologically plausible examples. Of course, his example can be defended as a *generalization* over actual perception-action processes, but this is exactly the position that embodied cognition has been reacting against from the start. The details of the perception-action processes provide the essential ingredients for intelligent behavior.

A radical embodied view stresses organism-environment coupling as the foundation of cognition on which increasingly elaborate decision-making processes can be built. Cognition is always tied to a particular, perceiving-acting agent. It does not exist in an abstract, disembodied way. The radical response to the off-line reasoning argument must stress that reasoning is an aspect of an embodied agent that continues to survive due to its perception-action capacities. Of course, a particular set of cognitive processes can have off-line characteristics, but it remains an extension of perception-action capacities. Any talk about cognition must be tied to particular, physically realizable agents.

As said, all this remains controversial, but it is a coherent picture of cognition that diverges from traditional views in an important way. Its conceptual development will require work on at least three basic issues. (1) A notion of *minimal agency* will be required to answer the agent ascription problem. (2) The turn to biology shows not only the complexity of even the most minimal forms of biological agency. It also highlights the enormous diversity and gradual increase in capacities when one surveys the different phyla. A notion of what might be called *layers of agency* will be required as part of a differentiated view that traces the many different extensions of agency when going from flatworms, to annelids, to mollusks, to arthropods and of course all different vertebrates including ourselves. (3) An explanation is needed for the fact why the disembodied view of cognition seems so plausible for humans. Intriguingly, current work on imitation and the cultural origins of human cognition might give an inkling where to search for answers on this problem (e.g. Tomasello, 1999).

To conclude, Beer's categorization model does not highlight the conceptual reasons for defending a radically embodied view against more traditional interpretations. At the same time, his model is an admirable example how the dynamical organism-environment interactions of such a radical view might look like.

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