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The Meaning of Embodiment

Julian Kiverstein

Institute of Logic, Language and Computation, University of Amsterdam

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Abstract

There is substantial disagreement among philosophers of embodied cognitive science about the meaning of embodiment. In what follows, I describe three different views that can be found in the current literature. I show how this debate centers around the question of whether the science of embodied cognition can retain the computer theory of mind. One view, which I will label body functionalism, takes the body to play the functional role of linking external resources for problem solving with internal biological machinery. Embodiment is thus understood in terms of the role the body plays in supporting the computational circuits that realize cognition. Body enactivism argues by contrast that no computational account of cognition can account for the role of commonsense knowledge in our everyday practical engagement with the world. I will attempt a reconciliation of these seemingly opposed views.

Keywords: Artificial intelligence; Commonsense knowledge; Computer theory of mind; Dynamical cognitive science; Embodiment; Emotion and cognition; Enaction; Frame problem; Functionalism; Hubert Dreyfus; Predictive coding; Radical embodiment; Symbol grounding problem

1. Introduction

Embodiment has generated much excitement within philosophy of cognitive science over the past 20 years. Somewhat surprisingly, however, there remains much disagreement about just what it means to say that cognition is *embodied*.[1] On one view, which I will call *body-functionalism*, the body is understood as playing a role in implementing the computational machinery that underpins our cognitive capacities. A second view attempts to deflate talk of embodiment by arguing along traditional lines that the body makes a contribution to information processing only by supplying inputs to the brain, or by executing motor instructions

Correspondence should be sent to Julian Kiverstein, Institute of Logic, Language and Computation, University of Amsterdam, 1021 GC, Amsterdam, The Netherlands. E-mail: j.d.kiverstein@uva.nl

sent out from the brain. I will label this position *body-conservativism* as it seeks to preserve the traditional approaches to cognitive science in the face of calls for revolution and reform from the philosophers of embodiment. A third, somewhat heterodox and radical view, entirely eschews the computational theory of cognition on account of its alleged failure to explain how representations can provide an agent with commonsense knowledge of the world. On this third view, the body is understood as the source of meaning. I will call this view *body-enactivism*, as it is concerned with articulating the ways in which the body can *enact* or make a situation meaningful to an agent.

Ultimately, what separates these three views of the body is a disagreement about the status of the founding idea in cognitive science that cognitive processes are computational processes. The disagreement concerning the meaning of embodiment can be traced back to a more fundamental disagreement about whether the contribution of the body to cognition can be understood along computational lines. I will have something brief to say on this issue in the final section of my article. My main aim, however, is not to make an intervention in this long-running debate. I will concentrate on providing an overview of one way in which body enactivism might be developed in a way that maximally emphasizes the contrast with body functionalism. I'm going to more or less sideline the discussion of body conservatism in this article, since the body enactivist position claims to spell trouble for any view committed to the computer theory of mind. I will concentrate instead on the conflict with body functionalism. If there really are two different and incompatible notions of embodiment at play in philosophical discussions of embodied cognition, an important and urgent question would then arise as to which of these concepts is the one we should work with as philosophers and scientists. At the very best, it would be helpful to know which of the concepts is the most useful and productive for the daily business of doing cognitive science. Fortunately, I shall suggest that this conflict may turn out to be more apparent than real, so these difficult questions are ones we may not need to settle now after all. I doubt, however, that this is a fight that can be won in a single round. What is at issue is a fundamental disagreement about what exactly we mean when we say the mind is embodied. My aim is not to attempt a definitive answer to this question, but rather to highlight that this is a question about which there is still a debate to be had.

2. The philosophy of embodied cognition: A brief history

Arguably, the 4EA (Embodied, Embedded, Extended, Enacted, Affective) movement within philosophy of cognitive science received its official launch 20 years ago with the publication of Varela, Thompson, and Rosch's *The Embodied Mind* (Varela, Thompson, & Rosch, 1991). The book sought to bring about nothing short of a paradigm change, developing a sustained argument against the traditional, cognitivist view in cognitive science of cognition as symbol crunching, information processing. *The Embodied Mind* offered a whole new set of metaphors for doing cognitive science. Cognition was to be understood in terms of the *sense-making activities* of living organisms. Cognitive systems were conceptualized as autonomous systems that couple with the environment in such a way as to ''bring forth'' and construct domains of skillful activity.[2] These were metaphors that were drawn from the emerging science of complex systems, from cognitive linguistics, but also from Buddhist meditative traditions and from phenomenological thinkers such as Martin Heidegger, Maurice Merleau-Ponty, and Edmund Husserl.

This was heady stuff, for many philosophers like myself encountering these ideas for the first time, but the book failed to ignite revolution within the rank and file of philosophers with an eye on cognitive science. Daniel Dennett in his 1993 review of the book expressed gratitude to Varela and his co-authors for ‘‘a variety of important nudges away from… optional features of standard cog sci dogma.’’ He went on to add that so far as he was concerned, the case had not yet been made for revolution, and it was ‘‘business as normal’’ for cognitive science, a view, which regrettably, most philosophers of cognitive science seemed to have shared.

Many mainstream philosophers of cognitive science will probably have first heard about embodied cognition *via* Clark’s (1997) *Being There*. Clark too had a radical sounding message, but unlike Varela and colleagues, he was after root-and-branches reform of the cognitive sciences, rather than out-and-out revolution. For Clark, the price of taking embodiment seriously was a thorough going rejection of any distinction between perception, action, and cognition. Such a distinction can be found in Fodor’s (1983) division of the mind into modular, domain-specific perceptual and motor processes on the one hand, and general purpose central cognition, the natural home of thought and reason, on the other. Clark proposed to replace this view of cognitive architecture with a vision of bodily action and elements of the environment as deeply integrated into ‘‘the processing loops that result in intelligent action’’ (Clark, 1997, p. xii). Thought and reason, Clark argued, are the upshot of our brains working in partnership with the non-neural body and environmental structures. The argument unfolded through an elegant synthesis of ideas drawn from post connectionist computational modeling, situated robotics, human computer interaction, developmental psychology, vision science, and even management studies. Clark drew on these disparate resources to argue that the human brain does not carry out its functions in isolation from body and world but should instead be thought of as the controller of our embodied activity in the world.

Clark’s message was in part a conciliatory one; minds may be essentially embodied and embedded, but they still ‘‘*depend* crucially on brains which compute and represent’’ (1997, p. 143). The implication for cognitive science, as Clark saw it, was not the abandonment of the computer theory of mind, but some tweaking and refining so as to make room for the body, tools, and technologies and possibly even for other people to perform genuine computational work in cognition. The brain, Clark told us, does not much care about where it does its computational processing. Sometimes computation can be done through the recruitment and bodily manipulation of external artifacts; other times it can be done entirely within the head. This is a decision the brain makes on the fly, temporarily constructing short-lived coalitions of neural, bodily, and cultural artifacts when this is the most efficient strategy for accomplishing a cognitive task.[3]

These calls for revolution and reform were unsurprisingly met with trenchant resistance by defenders of the tradition. Adams and Aizawa (2001, 2008, 2010), for instance, have argued with great vigor for a return to Fodor's cognitivist view of perception and action as at best providing the inputs and outputs of cognitive processes housed within the brain. They have accused those with a reforming (or worse still, a revolutionary) agenda of conflating the trivial claim that body and environment make a causal contribution to cognitive processes for the more radical claim that cognitive processes are embodied and extended. If body and world can only ever make causal contributions to cognitive processes, the old Fodorian idea of perception and action as buffering central cognition would seem to survive relatively unscathed. The challenge was therefore laid down to the philosophers of embodiment to show that body and world can be genuine parts of cognitive processes, and not just channels for inputs and instruments for producing outputs.

From its very inception then, the philosophical literature on embodied cognition has contained a fault line separating the radicals and revolutionaries calling for regime change, from would-be reformers and conservative defenders of the status quo. Reformists, in common with conservatives, retain the idea of cognition as computation, but they depart from conservatives in seeking to enrich the traditional idea of computation so as to open up space for body and environment to play a role in implementing information processing.

Fast-forward to today, and the controversy rolls on. Anthony Chemero has written a wonderful manifesto for what he calls a ''radical embodied cognitive science'' (Chemero, 2009). His vision of radical embodiment is drawn from a synthesis of dynamical systems approaches to cognitive science and ecological theories of perception originally formulated by J. J. Gibson, and subsequently developed in great technical detail by Turvey, Shaw, and Mace. Just as Varela and colleagues did 20 years ago, Chemero argues for an approach to cognitive science that entirely rejects talk of computation and representation. Unlike Varela and colleagues, Chemero makes his argument for revolution in cognitive science purely on explanatory grounds. He suggests that any more general philosophical argument for radical embodiment will prove a hard sell and will ultimately fail to persuade anybody not already persuaded (c.f. Dennett, 1993). His strategy is therefore to make an argument for radical embodied cognitive science based on ''inference to the best explanation.'' That being said, in his discussion of affordances in the final part of the book, Chemero makes common cause with the enactive program in cognitive science. He proposes an integration of ecological and enactive cognitive science ''under the banner of radical embodied cognitive science'' (Dennett, 1993, p. 154). The body enactivist view I will go on to develop below (in Section 3) can be understood as a first stab at developing such an integrative project. Before we get there, I will first delve a little more deeply into this controversy surrounding the validity of the computer theory of mind.

3. The meaning of embodiment

Clark (2008, ch. 9) describes three ways in which embodiment ''matters for mind and cognition.'' The first is nicely captured by work within robotics on morphological computation that shows how body morphology and biomechanics can be exploited in problem solving to do computational work that would otherwise have to be performed by the brain.[4]

The second role for the body that Clark identifies is in structuring flows of information, creating and eliciting data required to solve a problem.[5] This body of research shows, for instance, that using a number of different measures of information, self-generated movements increase the amount of information implicitly present in a sensory array. Finally, Clark argues that the body can co-opt external tools and technologies into its problem-solving routines so that the tools and technologies combine with the body to extend and augment cognition. Sensory substitution devices provide an elegant example of this variety of embodiment.[6] Skilled users of these devices report that they no longer feel the proximal stimulation from the device but are instead able to focus their attention on the distal causes of the stimulation.[7] The interface between the device and the user fades from awareness, and the device provides the user with transparent access to the world that compensates for their impaired sense.

In each of these examples of embodiment, the body makes a contribution to cognition by participating in a computational circuit. Embodiment is a key part of the explanation of how a cognitive task gets performed, but crucially the contribution of the body here is a *functional* or *causal* contribution. The body is one way of implementing an abstractly described computational operation (or, in the case of gesture, an encoding[8]) that could be implemented (though not always as efficiently) neurally, in silicon or in some other materials. Clark offers the following, useful summary of embodiment, as he intends us to understand it:

> The body, as we saw in earlier chapters, is the primary tool enabling the intelligent use of environmental structure. It acts as the mobile bridge that allows us to exploit the external world in ways that simplify and transform internal problem solving…The body is thus the go-between that links these two different (internal and external) sets of key information-processing resources. Hence, the body's role in such cases is that of a bridging instrument enabling the repeated emergence of new kinds of distributed information-processing organization…I am inclined, that is, to simply identify the body with whatever plays these (and doubtless some additional) roles in the genesis and organization of intelligent behaviour. (Clark, 2008, p. 208)

We have already seen how an opposing line of thought in the philosophy of embodied cognition denies that cognition is computation; a fortiori the contribution of the body to cognition cannot be that of implementing computation for these philosophers. These philosophers subscribe to a view of the body as the *source of meaning*. It will take some time to spell out this view, but we can begin to feel our way toward the general idea by briefly rehearsing a worry many philosophers and cognitive scientists have raised for the computer theory of mind. These theories have long been accused (perhaps somewhat unfairly) of failing to account for meaning and understanding.[9] The symbolic representations that are the bricks and mortar of computational approaches mean nothing to the computational systems that use them. The meaning attaching to symbols seems to derive instead from interpretation of the states a computational system goes through in computing a function or running a program. It is meaning that is ascribed to the system by an external observer attempting to make sense of the system's behavior in much the same way as an anthropologist might attempt to make sense of the behavior of members of a culture he's visiting for the first time. However, there is a compelling (though admittedly controversial) intuition that meaning is not simply in the eye of the beholder.[10] Symbolic representations are about situations that mean something to the agents whose behavior we are trying to explain. This is a fact that seems to be left unexplained by computational theories of cognition.

Sometimes this objection is presented as one about how symbols come to mean, represent, or refer to particular features of the external world. This is, however, not the problem I want to press here. Most proponents of the computer theory of mind accept that computation is not sufficient to account for meaning or understanding, and that a computational account of behavior is separate from an account of intentionality or meaning. Moreover, a number of attempts have been made at providing an account of intentionality consistent with what cognitive science tells us about the mind.[11]

We get closer to the problem that interests me if we ask how symbols (and representations more generally) can be *understood* as referring to *meaningful* situations by an agent attempting to work out what he should do to accomplish his goals and projects. A situation *S* is *meaningful* to an agent, I will say, when the agent knows how to act in *S* in such a way as to accomplish his projects and goals. Most of the situations we encounter in our everyday dealings with the world are meaningful in this sense. Our past experience equips us with a set of skills for dealing with familiar, regularly encountered situations. Our familiarity with the world is such that much of the time we succeed in acting without needing to reflect or deliberate on the question of what to do. It is the failure to account for this kind of skillful coping with the world, which I take to be a genuine problem that can be laid at the door of the computer theory of mind. The symbolic representations that are posited by the computer theory of mind do not mean anything for the computational systems that use them because they do not have a place within a wider body of commonsense understanding we have recourse to all the time in going about our daily business.

The problem I am raising has a superficial resemblance to what is sometimes called the symbol-grounding problem (Harnad, 1990). The symbol-grounding problem takes off from Searle's (1980) well-known arguments that syntax is not sufficient for semantics. As is well known, Searle argues that computational systems always carry out operations on symbolic representation according to the syntactic form of those representations, not on the basis of their meaning. Harnad took up Searle's worry in arguing that the representations appealed to in computational explanations are meaningless because they are not ''grounded'' in the right way in perception and action. Larry Barsalou agreed and put forward his account of concepts as perceptual symbols in response.[12] Barsalou proposed that we understand concepts as ''perceptual symbols'' or re-enactments of neural representations that originated in perception and action. This reconstruction of perceptual and motor experience grounds the symbolic representation, thereby providing the missing link between the symbol and what it stands for in the external world that is required for symbols to mean something for the cognitive agent.

Barsalou's theory of perceptual symbols does not, however, address the problem I am raising regarding our commonsense understanding of the world. The symbolic representations appealed to in computational explanation are meaningless, I suggest, not only because they are not linked to perception and action in the right way. All perception and action likewise take place against a background of skills and practices in virtue of which we know our way about in the world. The symbolic representations invoked in computational explanations are meaningless because they function in complete isolation from this body of background understanding. They float free of the interrelated contexts of activity we ordinarily deal with based on our commonsense understanding. Indeed, this problem would seem to apply equally to the perceptual and motor representations Barsalou takes to ground symbolic representation. Perceptual and motor representations can only perform this role in the context of a wider set of skills and practices in virtue of which we know how to find our way about in the world.

This is a point that has long been insisted upon by Hubert Dreyfus in his attack on attempts by computer scientists to engineer artificial intelligence.[13] Computers have to be programmed to deal with the situations we fluently navigate on the basis of symbolic representations of context-independent facts, and explicit rules for manipulating and transforming those representations. Dreyfus argues that no machine that works in this way will ever be capable of the flexible and adaptive response to the open-ended variety of situations we humans can handle. The root of the problem for computational approaches is, according to Dreyfus, an assumption that as agents, we encounter situations that are *meaningless* to us. We then face the problem of having to work out what to do in those situations on the basis of rules and representations of context-independent facts. Dreyfus argues that an agent in such an epistemic predicament will always have to work out what representations are relevant to his current situation on the basis of representations and rules that are context independent. The agent will always be operating outside of a world of meaningful situations, but starting out from such a position, it will continuously run up against the problem of how to use what it knows so as to finds its way into a world of meaningful situations.

The solution to the problem, Dreyfus argues, lies in rejecting the assumption that agents start out confronting a meaningless world, which they must work out how to navigate *via* rules and representations of facts. We are experts in much of what we do, and as we acquire the skills typical of an expert, so we become better and better at discriminating between particular situations and the responses appropriate to the specifics of each situation. Normally, we find ourselves in situations that offer a rich array of possibilities for action, and some of these invitations to act stand out as particularly alluring to us given our current projects and interests. Dreyfus writes:

> We need to consider the possibility that embodied beings like us take as input energy from the physical universe and process it in such a way as to open them to a world organised in terms of their needs, interests, and bodily capacities, without their *minds* needing to impose a meaning on a meaningless Given… (Dreyfus, 2006, p. 45)

Dreyfus appeals to embodiment to explain how perception can open us to a world ''organized'' in terms of our ''needs and interests.'' He follows the phenomenological philosopher Merleau-Ponty in arguing that it is the body that ''gears'' us into a meaningful world. The body, by ''gearing'' us into the world is the source of meaning and understanding.[14] This is something the body accomplishes not through the rule-governed manipulation and transformation of symbolic representations. According to Dreyfus, there can be no computational account of our ability to find our way about in a world of familiar situations. How then does the body make meaning?

We can distinguish between two problems the body must assist an agent in solving if it is to disclose a meaningful world to an agent. First, the body must somehow contribute to the agent's sense of what to do within a specific context of activity. Second, it must provide the agent with an ability to smoothly shift from a particular context of activity into one of an open-ended number of other possible contexts of activity in a way that fits with an animal's needs and interests.[15] In the next section, we will consider each of these problems in turn.

4. How the body makes meaning

How does the body equip an agent for dealing competently with specific situations? I suggest that this is in part a matter of the agent's acquiring the relevant skills so that he or she can detect the ''affordances'' or features of a situation that invite action from an agent with the requisite abilities.[16] As an agent acquires a skill through repeated practice, so his learning feeds back into the way in which he perceives the world. Dreyfus (2006) gives the vivid example of moving to a foreign city: As you learn to find your way about in the city the streets begin to look familiar to you, and new opportunities for action become salient that hitherto went unnoticed. It is the same for the skillful agent: As she becomes increasingly competent in some domain of activity, she sharpens her ability to perceptually discriminate subtle differences in a vast array of different situations. Her past experience becomes sedimented in her embodied performance, priming her to respond fluently and appropriately to the particularities of a host of different situations.

Bodily affect plays a crucial role in the skilled agent's ability to tailor her actions to a dynamically changing environment in the flow of action.[17] Rietveld (2008a) has described in rich detail how perception of the environment involves an act of evaluation, or emotional appraisal that reflect the agent's immediate concerns, needs, and interests. Rietveld follows the emotion theorist Frijda's (1986, 2007) account of emotional appraisal. Frijda understands appraisal in terms of states of action readiness elicited by events in the environment that matter and are of concern to the agent. Meeting a bear in the woods immediately generates in the perceiver a preparation to flee, to take a classic example. A crucial part of acquiring a skill is that we learn to evaluate what responses are appropriate to the situation we find ourselves in. Through repeatedly practicing a skill and improving and refining her performance, the skilled agent literally comes to embody a feel for a wide variety of dynamically changing situations. Following Frijda, Rietveld suggests this feeling for the situation that the expert acquires can be understood in terms of states of action readiness. The process of acquiring a feel for what to do in different situations, which I have suggested is a key part of acquiring a skill, also makes the agent ready to act in ways that are appropriate both to her concerns and to the particularities of the situation in which she finds herself.[18]

We can find some support for this hypothesis from cognitive neuroscientific work on the medial premotor network. Goldberg (1985) has hypothesized that the medial network has the function of anticipating the outcome of actions performed in familiar domains. Skill learning crucially involves anticipatory action control in which the agent measures their performance against some predicted reward. As the agent becomes increasingly skilled, so the agent gets better at selecting actions that result in rewarding outcomes. The dorsal ACC (dACC) enters into recurrent interactions with limbic and other cortical areas that encode information about past actions and their rewarding or costly outcomes (Kennerly, Walton, Behrens, Buckley, & Rushworth, 2006; Rietveld, 2008b; Rushworth, Walton, Kennerly, & Bannerman, 2004). This information about past successes and failure can then be retrieved and utilized by the dACC to estimate the likelihood of an action leading to a rewarding outcome.

What counts as a rewarding outcome for the agent? This takes us back to the proposal made earlier in this section that the skilled agent has a feeling for the situation such that she instinctively sees what to do, given her evaluation of the situation and what matters to her. It is this last feature of action selection I want to stress here that the agent's evaluation of a situation is relative to her concerns: An outcome counts as rewarding relative to the agent's concerns. Consider a skilled musician, for instance, performing a familiar piece she has played before many times. The rewarding outcome for her will lie in the way she performs the piece, and whether she succeeds in making the performance her own. This goal will be among the concerns that drive her performance. Her past experience will give her a sense of what works and what does not, so that in performing the piece her pre-motor system can correctly estimate which motor actions are likely to most closely approximate the effect she is aiming for. Whether a performance works will be evaluated by her pre-motor system in terms of her expectations about how she would like the piece to sound. When these expectations are frustrated, the actions she has produced will be negatively valenced, and this information can be used in motor control to improve and refine her performance and bring it closer to one that satisfies her expectations. As the agent learns a skill, her pre-motor system will get better and better at selecting actions evaluated by her as worth performing because they fulfill her concerns.[19]

The ACC is densely connected to the orbitofrontal cortex (OFC), an area responsible for predicting the rewarding or punishing nature of a given stimulus (Goldberg, 1985). Barrett and Bar (2009) describe how the OFC contain two functionally related circuits, a medial circuit that is connected to the dorsal ''where'' stream, and a lateral circuit connected to the ventral ''what'' stream.[20] They propose that the medial circuit in the OFC uses gist-level visual information about an object to ''modify the perceiver's bodily state to re-create the affective context in which the object was experienced in the past'' (Barrett & Bar, 2009, p. 1329). They suggest that this re-enactment of changes in bodily state in response to the object can be used to prepare and guide subsequent action. I suggest that the OFC may play a crucial role in the agent's appraisal of a situation, which I have argued (following Rietveld and Frijda) takes the form of action tendencies. The OFC and ACC work together so that the agent can bring its past experience to bear in preparing to respond to a situation appropriately, which is to say in a way that manifests what the agent cares about.

Let us turn now to the second problem I raised above as to how the body contributes to the agent's ability to smoothly shift out of one context of activity and into another perhaps wholly unrelated context of activity. This happens, for instance, when I'm immersed in writing and the phone rings, and I more or less fluently move from thinking about embodiment to chatting with a friend. Crucially, I can often do this without giving the matter any deliberation or thought; I can switch between skillful actions unreflectively. What underlies this ability? Any behavior I produce will be the outcome of the coordination of widely distributed areas of the brain, and one of the key problems in neuroscience is to account for this large-scale functional integration (see e.g., Edelman & Tononi, 2000; Friston, 2000; Sporns, 2010; Tsuda, 2001). Large-scale neural assemblies once they are formed are unstable, and it is precisely this instability that may allow for the rapid and fluid change in cognitive processes that is required for shifting between contexts of activity (Dreyfus, 2007; Rietveld, 2008b, ch. 4; Varela, 1999; Wheeler, 2008). Bodily affect plays a central part in explaining the transitions between cognitive processes in the brain. As I shift from thinking about the article I'm writing, to answering the telephone, so my concerns change. Different affordances in my environment show up as relevant because my appraisal of the environment means that certain affordances stand out as relevant to me and lead to the formation of different action tendencies.

My discussion of how the body makes meaning has focused on cases in which the agent is acting skillfully and unreflectively, without deliberating and consciously thinking about what to do. Of course, we can and often do have recourse to this kind of deliberate, reflective thinking, and an obvious objection to body enactivism is that it is entirely silent about how to explain cognitive capacities of this kind. This is, of course, not a new problem for embodied cognitive science, which has always faced the problem of explaining how embodied sensorimotor behavior scales up to the distinctively human capacities for high-level, logical, and rational thought.[21] I'm not going to attempt to grapple with this important problem in what remains of this (already too long) article. My concern has been with outlining an understanding of embodiment that might account for the commonsense understanding we have recourse to in our everyday dealings with the world. This commonsense understanding keys us into a particular situation, giving us a sense of what we must do if we are to accomplish goals that matter to us. In the final section of my article, I will consider whether this kind of embodiment really is so resistant to computational explanation in the way I have implied (following Dreyfus). It is this resistance that seems to set body enactivism in opposition with body functionalism. Can a computational explanation be given of how the body generates commonsense understanding? If the answer to this question turns out to be positive, we will certainly have enriched, but not replaced, the notion of embodiment employed by body functionalists.

5. Thinking on your feet

I have been arguing that with enough experience and practice in a variety of situations, the agent acquires an instinctive and intuitive sense of the specific response a situation invites, and can allow the situation to draw her actions from her. I suggested above that this is a capacity representational explanations will struggle to explain. As all computational explanations are also representational explanations,[22] the computer theory of mind would seem to fall foul of the same problem. Commonsense understanding would seem to resist computational explanation. Jerry Fodor pinpoints the difficulty succinctly and clearly in a passage Dreyfus likes to quote:

> The problem is to get the structure of an entire belief system to bear on individual occasions of belief fixation. We have, to put it bluntly, no computational formalisms that show us how to do this, and we have no idea how such formalisms might be developed. (Fodor, 1983, p. 128–129)

Fodor uses the term ''belief systems'' here to describe what we've been calling commonsense understanding. If we conceive of commonsense understanding along the lines of a body of representational states (as Fodor does), we must then explain how the agent succeeds in selecting from her body of representations, just those representations that are relevant to guiding the agent's action in a particular context of activity. This is a problem I have suggested we do not have to solve for the most part, as we are experts in much of what we do in our day-to-day lives. We can often blindly allow the situation to draw the appropriate response from us, and be more or less guaranteed that the action that unfolds will be one that is in line with our immediate concerns.

Sutton, McIlwain, Christensen, and Geeves (2011) have objected that to characterize embodied skills in this way is to underestimate the degree of thought that goes into even the most expert of embodied skillful performances. Much of our skillful behavior is, they suggest, the result of an interaction between controlled and automatic factors. They quote Brett's (1981) suggestion that embodied skills lie on a continuum from ''stereotyped responses to nearly identical situations'' at one extreme,[23] and reflective, deliberative, thoughtful action at the other extreme with the center being occupied by skillful performances in which ''attentiveness and variation are an essential part.'' (2011, p. 88). In a similar spirit, Wheeler (2008) has questioned how much of our everyday skillful behavior takes the form of hitch-free, smooth coping of the kind I have been discussing. He argues that more often than not we find ourselves encountering practical problems in our dealings with the world, which he suggests we solve by means of what he calls ''action-oriented representations'' that guide us to the right solution, enabling us to get our skilled performances back on track.[24] Wheeler takes action-oriented representations to be absolutely central to explaining how we deal competently with specific contexts of activity. He does not deny that our body is geared into the world in the way I have argued in the previous section, but he does not think this is sufficient to explain how an agent comes to find herself in a situation that is meaningful to her and she knows how to deal with. Action-oriented representations, he argues, will also be a core part of the story.

The explanation I have given above of how the body generates meaning has steadfastly avoided any appeal to internal representations. I have been arguing that bodily affect can work together with perception and procedural memory so that the agent can immediately and intuitively see what course of action is appropriate to the situation he is in. However, if Sutton and colleagues and Wheeler are correct, representations play a necessary role in expert behavior. Thus, the case against the computer theory of mind begins to unravel. An individual's success in skillfully dealing with specific contexts of activity will depend on the manipulation of representations, and the meaning she assigns to the situation will derive from the representations she deploys rather than from her bodily engagement with the world.[25]

This kind of worry for the body enactivist finds further support in Andy Clark's current work on predictive coding models of brain function.[26] According to these models, the central problem facing our perceptual systems is to learn about the world on the basis of states and changes to what Clark calls its ''own internal registers.'' The way our brains solve this problem is to learn statistical regularities relating to the ways in which sensory inputs tend to vary over space and time. It is a near consensus that perceptual processing in the brain is organized hierarchically. Predictive coding models hypothesize that each layer in the hierarchy employs statistical knowledge to predict the current inputs it will receive from the layer below. When the predictions are correct, there is a match between expected and actual input and the result is perception. When there is a mismatch, an error signal is generated that can be used to update the neural representation at the higher level until the right hypothesis is found that best captures the regularities in inputs from lower levels. On this model of brain function, perceptual processing is all about producing the best models of high-level regularities that allow for the prediction of lower level inputs. Hohwy (2010, p. 3) sums up the basic idea well; he tells us ''the task for the brain is to make life less surprising.'' When each layer in the hierarchy can predict the pattern of activity in the population of neurons in the layer below, this is because the brain has learned to generate models that capture genuine regularities in sensory signals that can ultimately be traced back to regularities in the external world.

Now notice the very same model can be applied to motor control to account for how a skilled agent comes to be geared into a specific situation in such a way as to respond directly to what is relevant. Actions have sensory consequences, some interoceptive (e.g., proprioception, kinesthesis) and some exteroceptive (e.g., visual, tactile, etc.). The predictive brain generates high-level representations of the world that include interoceptive and exteroceptive predictions. As the agent gets progressively expert at performing a skilled behavior this is because her interoceptive and exteroceptive predictions become increasingly accurate. Her actions have consequences that are less and less surprising and are brought increasingly under her control. Friston, Mattout, and Kilner (2011) explain the idea as follows:

> In this picture of the brain, neurons represent both cause and consequence: They encode conditional expectations about hidden states in the world causing sensory data, while at the same causing those state vicariously through action. (Friston, Mattout, & Kilner, 2011, p. 138)

The predictive brain is, however, also a computational brain. If we can give a predictive coding explanation of how the body gears into the world along the lines just sketched, this would be to provide a computational explanation of how the body makes meaning. Of course, I'm not laying claim to having pulled off this remarkable trick with these brief comments.[27] I have, however, gestured in the direction of how one might go about telling such a story that is convergent with an increasingly popular take on how brains work. If such an account can get off the ground, it will follow that the philosophers of embodiment might be singing from the same page after all.

Would it follow that a victory goes to the body functionalist or even worse to the body conservative? Not at all, the body enactivist understands embodiment in terms of bodily skills we draw on all the time when we act unreflectively, and in virtue of which we can encounter situations that are meaningful. It may be the case the contribution of the brain is that of coordinating a cascade of increasingly fine-grained and detailed predictions, but all of this is taking place in the service of a sense-making activity of an embodied agent. But have not we now given an argument for treating the brain as playing a privileged role in just the way the body conservative argues with body and world playing at best a supporting role? To fully respond to this objection is a task for another occasion. As a gesture in the direction of a reply, however, consider the role that was assigned to affect above in directing the agent to relevant possibilities for action both within and across contexts of activity. The dynamic interaction between perception, affect, and action I have pointed to above cannot be adequately accounted for on a linear model of causality in which perception provides inputs to a brain which functions as a command center issuing instructions to the body.

Notes

1. In what follows, my focus will be entirely on discussions of embodiment within the philosophy of cognitive science. If I am right, this disagreement I will identify concerning the meaning of embodiment also finds an echo within embodied cognitive science, as the philosophical views I will be exploring are all explicitly drawn from, and informed by, the cognitive sciences. Embodiment is, of course, much discussed in many other areas of philosophy, in particular feminist philosophy, and it is an interesting question to what extent, if at all, the notion of embodiment employed in this literature overlaps with those employed in philosophy of cognitive science.
2. These ideas are developed in much more detail by Thompson (2007). Also see Stewart, Gapenne, and Di Paolo (2011), and the special issue of *Journal of Consciousness Studies* (Schlicht 2011), which includes a number of excellent critical articles discussing Thompson (2007) and informative replies from Thompson.
3. I'm drawing on formulations from Clark (2008) here, but the idea of ''softly-assembled'' cognitive systems is already anticipated in his (1997). Clark finds evidence for this view of cognitive systems as assembled on the fly in the work of Wayne Gray and colleagues; see, for instance, Gray and Wu (2004). For a critical discussion of Clark's interpretation of Gray's work, see Rupert (2009, section 5.3.2).
4. For an excellent review of this work, see Pfeifer and Bongard (2007).
5. Clark cites Lungarella, Pegors, Bulwinkle, and Sporns (2005).

6. For further discussion of sensory substitution devices and their connection to embodiment, see Kiverstein, Farina, and Clark (in press).
7. See, for example, Auvray, Hanneton, Lenay, and O'Regan (2005) and follow-up studies by Siegle and Warren (2010).
8. For discussion of the case of gesture, see Clark (2008, section 6.7–8). Clark is appealing here to the work of Susan Goldin-Meadow. For an overview of her work, see Goldin-Meadow (2003).
9. See Rupert (2009, ch. 11) and Shapiro (2010, ch. 6) for a careful, critical assessment of the symbol-grounding problem.
10. This intuition would, of course, be challenged by philosophers sympathetic to Daniel Dennett's treatment of intentionality; see, for example, Dennett (1987, 1991).
11. Shapiro (2010) makes this point in his discussion of the symbol grounding problem. For some prominent attempts at ''naturalizing intentionality,'' see, for instance, Fodor (1987), Millikan (1984, 1993, 2004), Dretske (1981, 1988), and Rupert (1998).
12. See, for example, Barsalou (1999) and Prinz (2002) for a carefully worked out philosophical version of this view.
13. For the classic statement of the problem, see Dreyfus (1992). For a more recent treatment of the problem in which Dreyfus also critiques research programs whose goal is engineering an *embodied* artificial intelligence, see Dreyfus (2007).
14. The idea from Merleau-Ponty (1962) that the lived body makes meaning by ''gearing us into the world'' is one that is common to my position and enactivism as it is normally developed by philosophers following in the footsteps of Francisco Varela (see, e.g., Stewart et al., 2011 and Thompson, 2007). However, absolutely central to this tradition is the idea of the continuity of life and mind, a thesis I have said nothing about in my article. As Thompson explains in a recent *précis* of his book:

    > Life and mind share a core set of formal or organisational properties, and the formal or organisational properties distinctive of mind are an enriched version of those fundamental to life. (Thompson, 2011, p. 10)

    This life–mind continuity thesis generates a conflict with body functionalism (see Di Paolo, 2009; Thompson & Stapleton, 2009; Wheeler, 2011). What I'm calling body enactivism tries to side step this debate, but then why label my position ''enactive,'' given the absolute centrality of the life–mind continuity thesis to the enactive program? My reasons for doing so lie with the common genesis of our ideas in Merleau-Ponty's philosophy (I would add Heidegger to the mix, see Kiverstein [2012]). I fully agree, for instance, with Thomspon that ''behaviour is always a structured and dynamic whole, in which organism and milieu participate not as externally related stimulus and reaction, but as internally related situation and response'' (Thompson, 2011, p. 11). This much, however, falls out of a radical program in embodied cognitive science that synthesizes ecological and dynamical ideas, but it is not obvious to me that such a program must commit to any full-blown life–mind continuity thesis. It should be noted, however, that anyone that accepts such a thesis will have strong grounds for pushing back against the ecumenical message I sound in the final section of my article. There are a number of important and deep issues here that need to be taken up in future work.

15. The two problems I have just outlined are aspects of what computer scientists call ''the frame problem'' in artificial intelligence. This is the problem of programming a machine to retrieve from all the knowledge it has stored in memory and in its perceptual buffers, the subset of information that is relevant to the current context of activity, so as to bring this information to bear in belief formation or action selection. (For an overview of the problem and work addressing it, see Shanahan [2009]). The division I'm making between these two aspects of the problem, I owe to Wheeler (2008).
16. The notion of ''affordances'' I'm employing here is, of course, borrowed from ecological psychology. For fuller discussion of this technical concept, see Chemero (2009, ch. 7). My definition is loosely modeled on his. The integration of ecological psychology and enactive cognitive science I promised in the opening section of my article hinges around this notion of affordances.
17. Affect is ''bodily'' in the sense that it is generated in the body in the form of arousal or changes in somatovisceral states picked up interoceptively (see, e.g., Feldman Barrett, Mesquita, Ochsner, & Gross, 2007). According to Damasio's influential somatic marker hypothesis, changes in somatovisceral states (or neural representations of such changes in the form of what Damasio calls ''as if loops'') signal to the agent the positive or negative valence of action outcomes that can then be factored into the agent's decision making (Damasio, 1994). The suggestion I'm currently exploring is that somatic markers may also play a role in the production of skillful behavior.
18. We can make a productive comparison here with the findings (reviewed in Dijksterhuis and Nordgren [2006]) that subjects are much better in making a complex decision like choosing the best apartment, the less conscious thought they give to the decision. Dijksterhuis and colleagues found across a number of studies that conscious thought seems to get in the way of our making the best decision, and we choose much better when we hand the decision making over to unconscious thought processes. Skilled agents likewise perform at their best when they hand over their everyday decision making to their bodies. It is important, however, not to overstate the similarity between the kind of automatic, unconscious decision making Dijksterhuis and his lab investigate and the kinds of affectively driven, skillful unreflective behaviors I am discussing. Part of Dijksterhuis's argument is that conscious thinking can lead to bad decisions because of processing constraints that do not apply in the case of unconscious thinking. Something analogous to reflection is still taking place on their view before a decision is reached, but it unfolds unconsciously and shows up in consciousness as a gut feeling. By contrast, I'm arguing that perception, affect, and procedural memory can work together so as to generate action without the agent needing to engage in any reflection even of an unconscious variety. This is because of the way in which the skilled body is geared into meaningful situations.
19. It should be noted that here I'm going beyond anything that is to be found in the neuroscience literature on reinforcement learning. Rushworth et al. (2004), for instance, describe actions as worth performing when the benefits the action will yield in the

long run outweigh the short-term costs of performing the action. However, this still leaves unanswered the question of when an action has consequences that are beneficial to the agent. See Rietveld (2008b) for an interesting discussion of this issue that influenced my own thinking on this question.

20. The distinction between the ''what'' and ''where'' visual pathways originates from Ungerleider and Mishkin (1982). Milner and Goodale (1995/2006) have developed and extended the original proposal in distinguishing a dorsal visual pathway dedicated to action from a ventral visual stream dedicated to perception. Jacob and Jeanerrod (2003) offer some refinements of this dualistic model, and Schenk and McIntosh (2010) offer some important criticisms.
21. See Wilson (2008) for a promising evolutionary explanation.
22. Here I'm following Fodor's (1981) slogan ''No computation, without representation.'' For a recent dissenting voice, see Piccinini (2006).
23. It should be noted that expert behavior of the kind I have been describing is never ''stereotyped response to an identical situation.'' The agent is continually bringing his past experiences to bear in each encounter with the world, and each time the agent acquires a new experience and refines his skill, and his sensitivity to the action appropriate to the situation so the brain forms new attractor states that reshape the overall attractor landscape of which they are a part. Past experience and learning feeds back into each perceptual encounter with the world so that as Dreyfus puts it, ''no two experiences of the world are ever exactly alike'' (2007, p. 1154).
24. Action-oriented representations, Wheeler tells us, are marked out by three features: (a) they are action specific, tailored to the job of producing particular behaviors; (b) they are egocentric, encoding the environment in terms of agent-centered properties (e.g., position relative to the agent); and (c) they are intrinsically context dependent, tied to the production of actions in specific contexts of activity.
25. This slightly exaggerates the problem for the body enactivist, as action-oriented representations have a kind of content that is specified in terms of the body's engagement with the world (see note 24 above). The point stands, however, that what Wheeler is offering is a representational explanation of how a situation comes to be meaningful for an agent and the body enactivist eschews representational explanation.
26. See Clark (2013, forthcoming).
27. Erik Rietveld has pointed out to me to that our capacity to respond skillfully to what is relevant in a given situation may still hold a problem for any computational approach, even one reformulated along the lines I sketch above. Whenever we act skillfully, we are not only sensitive to what is relevant in our current contexts of activity but also to other potentially relevant situations that lie on the horizon of what we are doing. As everything is potentially relevant to everything else to have a capacity for context-sensitive relevance in one situation, we must also have such a sensitivity to an open-ended number of other situations. Dynamical explanations of the kind we have seen body enactivists appeal to seem to be able to handle such complexity, but it remains a significant challenge to computational accounts to show that they can also do so. For further discussion of this problem, see Rietveld (2012).

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