Part I

BACKDROP

CHAPTER 1

A Short Primer on Situated Cognition

Philip Robbins and Murat Aydede

In recent years there has been a lot of buzz about a new trend in cognitive science. The trend is associated with terms like *embodiment*, *enactivism*, *distributed cognition*, and *the extended mind*. The ideas expressed using these terms are a diverse and sundry lot, but three of them stand out as especially central. First, cognition depends not just on the brain but also on the body (the embodiment thesis). Second, cognitive activity routinely exploits structure in the natural and social environment (the embedding thesis). Third, the boundaries of cognition extend beyond the boundaries of individual organisms (the extension thesis). Each of these theses contributes to a picture of mental activity as dependent on the situation or context in which it occurs, whether that situation or context is relatively local (as in the case of embodiment) or relatively global (as in the case of embedding and extension). It is this picture of the mind that lies at the heart of research on situated cognition. According to our usage, then, situated cognition is the genus, and embodied, enactive, embedded, and distributed cognition and their ilk are species. This usage is not standard, though it seems to us as good as any (for competing proposals, see Anderson, 2003; Clancey, 1997; Wilson, 2002).

In this brief introductory chapter, we present a bird's-eye view of the conceptual landscape of situated cognition as seen from each of the three angles noted previously: embodiment, embedding, and extension. Our aim is to orient the reader, if only in a rough and preliminary way, to the sprawling territory of this handbook.

1. The Embodied Mind

Interest in embodiment – in "how the body shapes the mind," as the title of Gallagher (2005) neatly puts it – has multiple sources. Chief among them is a concern about the basis of mental representation. From a foundational perspective, the concept of embodiment matters because it offers help with the notorious "symbol-grounding problem," that is, the problem of explaining how representations acquire meaning (Anderson, 2003; Harnad, 1990; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005).

This is a pressing problem for cognitive science. Theories of cognition are awash in representations, and the explanatory value of those representations depends on their meaningfulness, in real-world terms, for the agents that deploy them. A natural way to underwrite that meaningfulness is by grounding representations in an agent's capacities for sensing the world and acting in it:

> *Grounding the symbol for 'chair', for instance, involves both the reliable detection of chairs, and also the appropriate reactions to them. . . . The agent must know what sitting is and be able to systematically relate that knowledge to the perceived scene, and thereby see what things (even if non-standardly) afford sitting. In the normal course of things, such knowledge is gained by mastering the skill of sitting (not to mention the related skills of walking, standing up, and moving between sitting and standing), including refining one's perceptual judgments as to what objects invite or allow these behaviors; grounding 'chair', that is to say, involves a very specific set of physical skills and experiences. (Anderson, 2003, pp. 102–103)*

This approach to the symbol-grounding problem makes it natural for us to attend to the role of the body in cognition. After all, our sensory and motor capacities depend on more than just the workings of the brain and spinal cord; they also depend on the workings of other parts of the body, such as the sensory organs, the musculoskeletal system, and relevant parts of the peripheral nervous system (e.g., sensory and motor nerves). Without the cooperation of the body, there can be no sensory inputs from the environment and no motor outputs from the agent – hence, no sensing or acting. And without sensing and acting to ground it, thought is empty.

This focus on the sensorimotor basis of cognition puts pressure on a traditional conception of cognitive architecture. According to what Hurley (1998) calls the "sandwich model," processing in the low-level peripheral systems responsible for sensing and acting is strictly segregated from processing in the high-level central systems responsible for thinking, and central processing operates over amodal representations. On the embodied view, the classical picture of the mind is fundamentally flawed. In particular, that view is belied by two important facts about the architecture of cognition: first, that modality-specific representations, not amodal representations, are the stuff out of which thoughts are made; second, that perception, thought, and action are *co-constituted*, that is, not just causally but also constitutively interdependent (more on this distinction follows).

Supposing, however, that the sandwich model is retired and replaced by a model in which cognition is sensorimotor to the core, it does not follow that cognition is embodied in the sense of requiring a body for its realization. For it could be that the sensorimotor basis of cognition resides solely at the central neural level, in sensory and motor areas of the brain. To see why, consider that sensorimotor skills can be exercised either on-line or off-line (Wilson, 2002). On-line sensorimotor processing occurs when we actively engage with the current task environment, taking in sensory input and producing motor output. Off-line processing occurs when we disengage from the environment to plan, reminisce, speculate, daydream, or otherwise think beyond the confines of the here and now. The distinction is important, because only in the on-line case is it plausible that sensorimotor capacities are body dependent. For off-line functioning, presumably all one needs is a working brain.

Accordingly, we should distinguish two ways in which cognition can be embodied: on-line and off-line (Niedenthal et al., 2005; Wilson, 2002). The idea of on-line embodiment refers to the dependence of cognition – that is, not just perceiving and acting but also thinking – on dynamic interactions between the sensorimotor brain and relevant parts of the body: sense organs, limbs, sensory and motor nerves, and the like. This is embodiment in a strict and literal sense, as it implicates the body directly. Off-line embodiment refers to the dependence of cognitive function on sensorimotor areas of the brain even in the absence of sensory input and motor output. This type of embodiment implicates the body only indirectly, by way of brain areas that process body-specific information (e.g., sensory and motor representations).

To illustrate this distinction, let us consider a couple of examples of embodiment effects in social psychology (Niedenthal et al., 2005). First, it appears that bodily postures and motor behavior influence evaluative attitudes toward novel objects. In one study, monolingual English speakers were asked to rate the attractiveness of Chinese ideographs after viewing the latter while performing different attitude-relevant motor behaviors (Cacioppo, Priester, & Bernston, 1993). Subjects rated those ideographs they saw while performing a positively valenced action (pushing upward on a table from below) more positively than ideographs they saw either while performing a negatively valenced action (pushing downward on the tabletop) or while performing no action at all. This looks to be an effect of on-line embodiment, as it suggests that actual motor behaviors, not just activity in motor areas of the brain, can influence attitude formation.

Contrast this case with another study of attitude processing. Subjects were presented with positively and negatively valenced words, such as *love* and *hate*, and asked to indicate when a word appeared either by pulling a lever toward themselves or by pushing it away (Chen & Bargh, 1999). In each trial, the subject's reaction time was recorded. As predicted, subjects responded more quickly when the valence of word and response behavior matched, pulling the lever more quickly in response to positive words and pushing the lever away more quickly in response to negative words. Embodiment theorists cite this finding as evidence that just thinking about something – that is, thinking about something in the absence of the thing itself – involves activity in motor areas of the brain. In particular, thinking about something positive, like love, involves positive motor imagery (approach), and thinking about something negative, like hate, involves negative motor imagery (avoidance). This result exemplifies off-line embodiment, insofar as it suggests that ostensibly extramotor capacities like lexical comprehension depend to some extent on motor brain function – a mainstay of embodied approaches to concepts and categorization (Glenberg & Kaschak, 2002; Lakoff & Johnson, 1999).

The distinction between on-line and off-line embodiment effects makes clear that not all forms of embodiment involve bodily dependence in a strict and literal sense. Indeed, most current research on embodiment focuses on the idea that cognition depends on the sensorimotor brain, with or without direct bodily involvement. (In that sense, *embodied cognition* is something of a misnomer, at least as far as the bulk of research that falls under this heading is concerned.) Relatively few researchers in the area highlight the bodily component of embodied cognition. A notable exception is Gallagher's (2005) account of the distinction between body image and body schema. In Gallagher's account, a body image is a "system of perceptions, attitudes, and beliefs pertaining to one's own body" (p. 24), a complex representational capacity that is realized by structures in the brain. A body schema, on the other hand, involves "motor capacities, abilities, and habits that both enable and constrain movement and the maintenance of posture" (p. 24), much of which is neither representational in character nor reducible to brain function. A body schema, unlike a body image, is "a dynamic, operative performance of the body, rather than a consciousness, image, or conceptual model of it" (p. 32). As such, only the body schema resides in the body proper; the body image is wholly a product of the brain. But if Gallagher is right, both body image and body schema have a shaping influence on cognitive performance in a variety of domains, from object perception to language to social cognition.

So far, in speaking of the dependence of cognition on the sensorimotor brain and body, we have been speaking of the idea that certain cognitive capacities depend on the structure of either the sensorimotor brain or the body, or both, for their physical realization. But dependence of this strong constitutive sort is a metaphysically demanding relation. It should not be confused with causal dependence, a weaker relation that is easier to satisfy (Adams & Aizawa, 2008; Block, 2005). Correlatively, we can distinguish between two grades of bodily involvement in mental affairs: one that requires the constitutive dependence of cognition on the sensorimotor brain and body, and one that requires only causal dependence. This distinction crosscuts the one mooted earlier, between on-line and off-line embodiment. Although the causal/constitutive distinction is less entrenched than the on-line/off-line distinction, especially outside of philosophy circles, it seems no less fundamental to an adequate understanding of the concept of embodiment. To see why, note that the studies described previously do not show that cognition constitutively depends on either the motor brain or the body. The most these studies show is some sort of causal dependence, in one or both directions. But causal dependencies are relatively cheap, metaphysically speaking. For this reason, among others, it may turn out that the import of embodiment for foundational debates in cognitive science is less revolutionary than is sometimes advertised (Adams & Aizawa, 2008).

2. The Embedded Mind

It seems natural to think of cognition as an interaction effect: the result, at least in part, of causal processes that span the boundary separating the individual organism from the natural, social, and cultural environment. To understand how cognitive work gets done, then, it is not enough to look at what goes on within individual organisms; we need to consider also the complex transactions between embodied minds and the embedding world. One type of such a transaction is the use of strategies for off-loading cognitive work onto the environment, a useful way to boost efficiency and extend one's epistemic reach.

One of the best articulations of the idea of cognitive off-loading involves the concept of epistemic action (Kirsh & Maglio, 1994). An epistemic action is an action designed to advance the problem solver's cause by revealing information about the task that is difficult to compute mentally. The best-known example of epistemic action involves the computer game Tetris, the goal of which is to orient falling blocks (called "zoids") so they form a maximally compact layer at the bottom of the screen. As the rate of fall accelerates, the player has less and less time to decide how to orient each block before it reaches the bottom. To cope better with this constraint, skilled players use actual physical movements on the keyboard to manipulate the blocks on the screen – a more efficient strategy than the "in-the-head" alternative of mentally rotating the blocks prior to orienting them on the screen with keystrokes. A roughly analogous strategy of cognitive off-loading facilitates more mundane tasks like grocery packing (Kirsh, 1995). The problem here is to arrange things so that heavy items go on the bottom, fragile items on top, and intermediate items in between. As the groceries continue to move along the conveyor belt, decisions about which items go where need to be made swiftly, to avoid pile-ups and clutter. As items come off the conveyor belt and enter the work space, skilled grocery packers often rapidly sort them by category (heavy, fragile, intermediate) into distinct spatial zones prior to placing each item in a bag. This procedure significantly decreases load on working memory relative to the alternative of mentally calculating the optimal placement of each item as it enters the work space, without the benefit of external spatial cues.

Both of these examples of epistemic action point to the importance of minimizing load on internal memory, on working memory in particular. This echoes the twin themes of Brooks's (1991) "world as its own model" (p. 140) and O'Regan's (1992) "world as an outside memory" (p. 461). The common idea here is that, instead of building up detailed internal models of the world that require continuous and costly updating, it pays to look up relevant information from the world on an as-needed basis. In other words, "rather than attempt to mentally store and manipulate all the relevant details about a situation, we physically store and manipulate those details out in the world, in the very situation itself" (Wilson, 2002, p. 629). The suggestion that intelligent agents do best when they travel informationally light, keeping internal representation and processing to a minimum, informs a wide spectrum of research on cognition in the situated tradition (Clark, 1997). Vision science affords a nice example of this trend in the form of research on change blindness. This is a phenomenon in which viewers fail to register dramatic changes in a visual scene – a phenomenon that some interpret as evidence that the visual system creates only sparse models of the world, giving rise to representational blind spots (O'Regan, 1992).

The embedding thesis, then, goes hand in hand with what Clark (1989) calls the "007 principle."

> *In general, evolved creatures will neither store nor process information in costly ways when they can use the structure of the environment and their operations upon it as a convenient stand-in for the information-processing operations concerned. That is, know only as much as you need to know to get the job done. (p. 64)*

Embedding, in turn, goes hand in hand with embodiment, as off-loading cognitive work depends heavily on sensorimotor capacities such as visual lookup, pattern recognition, and object manipulation. Epistemic actions, for instance, typically require embodiment in a strict and literal sense, as they involve real-time dynamic interaction with the local physical environment.

The theoretical and methodological import of embedding, however, is much wider. It points to the importance, in general, of studying cognition "in the wild," with careful attention to the complex interplay of processes spanning mind, body, and world (Hutchins, 1995). The scope of this ecological perspective on the mind is very broad indeed. Having expanded far beyond Gibson's (1979) work on vision, it informs research programs in virtually every area of psychology, from spatial navigation to language acquisition to social cognition. It is nicely illustrated by theories of social rationality, which try to explain human judgment and decision making in terms of the structure of the social environment (Gigerenzer, 2000). Somewhat further afield, the ecological view has begun to show up with increasing frequency in the literature on phenomenal consciousness, that is, consciousness in the "what-it's-like" sense popularized by Nagel (1974). It is implicit, for example, in the enactivist idea that the felt quality of visual awareness is a by-product of ongoing agent-environment interaction (Noë, 2004). It also informs constructivist conceptions of consciousness, such as the idea that an individual's conscious mental life tends to mirror that of socially salient others (Robbins, 2008). Both of these suggestions about the nature of phenomenal consciousness – arguably the last bastion of Cartesian internalism – reflect a newly invigorated ecological perspective on the mind.

3. The Extended Mind

Assigning an important explanatory role to brain-body and agent-environment interactions does not constitute a sharp break from classical cognitive science. Both the embodiment thesis and the embedding thesis can be seen as relatively modest proposals, given that they can be accommodated by relatively minor adjustments to the classical picture, such as the acknowledgment that "not all representations are enduring, not all are symbolic, not all are amodal, and not all are independent of the sensory and effector systems of the agent" (Markman & Dietrich, 2000, p. 474; see also Vera & Simon, 1993). The same cannot be so easily said, however, of the claim that cognition is *extended* – the claim that the boundaries of cognitive systems lie outside the envelope of individual organisms, encompassing features of the physical and social environment (Clark & Chalmers, 1998; Wilson, 2004). In this view, the mind leaks out into the world, and cognitive activity is distributed across individuals and situations. This is not your grandmother's metaphysics of mind; this is a brave new world. Why should anyone believe in it?

One part of the answer lies in the promise of dynamical systems theory – the intellectual offspring of classical control theory, or cybernetics (Ashby, 1956; Wiener, 1948; Young, 1964) – as an approach to modeling cognition (Beer, 1995; Thelen & Smith, 1994; van Gelder, 1995). Using the tools of dynamical systems theory, one can describe in a mathematically precise way how various states of a cognitive system change in relation to one another over time. Because those state changes depend as much on changes in the external environment as on changes in the internal one, it becomes as important for cognitive modeling to track causal processes that cross the boundary of the individual organism as it is to track those that lie within that boundary. In short, insofar as the mind is a dynamical system, it is natural to think of it as extending not just into the body but also into the world. The result is a radical challenge to traditional ways of thinking about the mind, Cartesian internalism in particular:

> *The Cartesian tradition is mistaken in supposing that the mind is an inner entity of any kind, whether mind-stuff, brain states, or whatever. Ontologically, mind is much more a matter of what we do within environmental and social possibilities and bounds. Twentieth-century anti-Cartesianism thus draws much of mind out, and in particular outside the skull. (van Gelder, 1995, p. 380)*

Implicit in this passage is a kind of slippery slope argument premised on a broad theoretical assumption. Grant that cognition is embodied and embedded – something that the dynamical systems approach takes more or less as a given – and it is a short distance to the conclusion that cognition is extended as well. Or so the reasoning goes.

Another part of the motivation behind the extension thesis traces back to a fictional (but realistic) scenario that Clark and Chalmers (1998) describe. They introduce a pair of characters named Otto and Inga. Otto is an Alzheimer's patient who supplements his deteriorating memory by carrying around a notebook stocked with useful information. Unable to recall the address of a museum he wishes to visit, Otto pulls out his trusty notebook, flips to the relevant page, looks up the address, and proceeds on his way. Neurotypical Inga, in contrast, has an intact memory and no need for such contrivances. When she decides to visit the museum, she simply recalls the address and sets off. Now, there are clear differences between the case of Otto and the case of Inga; Otto stores the information externally (on paper), whereas Inga stores it internally (in neurons); Otto retrieves the information by visual lookup, whereas Inga uses something like introspective recall; and so on. But according to Clark and Chalmers, these differences are relatively superficial. What is most salient about the cases of Otto and of Inga, viewed through a functionalist lens, are the similarities. Once these similarities are given their due, the moral of the story becomes clear: "When it comes to belief, there is nothing sacred about skull and skin. What makes some information count as a belief is the role it plays, and there is no reason why the relevant role can be played only from inside the body" (Clark & Chalmers, 1998, p. 14). As for the fact that this conception of mind runs afoul of folk intuitions, well, so much the worse for those intuitions.

This conclusion is not forced on us, however, and a number of theorists have urged that we resist it. For example, Rupert (2004) argues that generalizing memory to include cases like Otto's would have the untoward effect of voiding the most basic lawlike generalizations uncovered by traditional memory research, such as primacy, recency, and interference effects – and without furnishing anything comparably robust to substitute in their place. In short, insofar as the goal of scientific inquiry is to carve nature at its joints, and lawlike regularities are the best guide to the location of those joints, it is not clear that a fruitful science of extended memory is possible, even in principle. More generally, Adams and Aizawa (2008) contend that the standard argument for pushing the boundary of cognition beyond the individual organism rests on conflating the metaphysically important distinction between causation and constitution. As they point out, it is one thing to say that cognitive activity involves systematic causal interaction with things outside the head, and it is quite another to say that those things instantiate cognitive properties or undergo cognitive processes. Bridging this conceptual gap remains a major challenge for defenders of the extended mind.

4. Coda

Situated cognition is a many-splendored enterprise, spanning a wide range of projects in philosophy, psychology, neuroscience, anthropology, robotics, and other fields. In this chapter we have touched on a few of the themes running through this research, in an effort to convey some sense of what situated cognition is and what the excitement is about. The twenty-five chapters that follow it develop these themes, and other themes in the vicinity, in depth. Both individually and collectively, these chapters reveal what "getting situated" means to cognitive science, and why it matters.

References

Adams, F., & Aizawa, K. (2008). *The bounds of cognition*. Oxford: Blackwell.
Anderson, M. L. (2003). Embodied cognition: A field guide. *Artificial Intelligence*, 149, 91–130.
Ashby, W. R. (1956). *Introduction to cybernetics*. New York: Wiley.
Beer, R. D. (1995). A dynamical systems perspective on agent-environment interaction. *Artificial Intelligence*, 72, 173–215.
Block, N. (2005). Review of Alva Noë's *Action in Perception*. *Journal of Philosophy*, 102, 259–272.
Brooks, R. (1991). Intelligence without representation. *Artificial Intelligence*, 47, 139–159.
Cacioppo, J. T., Priester, J. R., & Bernston, G. G. (1993). Rudimentary determination of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology*, 65, 5–17.
Chen, S., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavior dispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin*, 25, 215–224.
Clancey, W. J. (1997). *Situated cognition*. Cambridge: Cambridge University Press.
Clark, A. (1989). *Microcognition*. Cambridge, MA: MIT Press.
Clark, A. (1997). *Being there*. Cambridge, MA: MIT Press.
Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis*, 58, 10–23.
Gallagher, S. (2005). *How the body shapes the mind*. Oxford: Oxford University Press.
Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.
Gigerenzer, G. (2000). *Adaptive thinking*. Oxford: Oxford University Press.
Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin and Review*, 9, 558–565.
Harnad, S. (1990). The symbol grounding problem. *Physica D*, 42, 335–346.
Hurley, S. L. (1998). *Consciousness in action*. Cambridge, MA: Harvard University Press.
Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.
Kirsh, D. (1995). The intelligent use of space. *Artificial Intelligence*, 7, 31–68.
Kirsh, D., & Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive Science*, 18, 513–549.
Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh*. New York: Basic Books.
Markman, A. B., & Dietrich, E. (2000). Extending the classical view of representation. *Trends in Cognitive Sciences*, 4, 470–475.
Nagel, T. (1974). What is it like to be a bat? *Philosophical Review*, 82, 435–450.
Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review*, 9, 184–211.

Noë, A. (2004). *Action in perception*. Cambridge, MA: MIT Press.

O'Regan, J. K. (1992). Solving the "real" mysteries of visual perception: The world as an outside memory. *Canadian Journal of Psychology*, 46, 461–488.

Robbins, P. (2008). Consciousness and the social mind. *Cognitive Systems Research*, 9, 15–23.

Rupert, R. (2004). Challenging the hypothesis of extended cognition. *Journal of Philosophy*, 101, 389–428.

Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action*. Cambridge, MA: MIT Press.

van Gelder, T. (1995). What might cognition be, if not computation? *Journal of Philosophy*, 91, 345–381.

Vera, A. H., & Simon, H. A. (1993). Situated action: A symbolic interpretation. *Cognitive Science*, 17, 7–48.

Wiener, N. (1948). *Cybernetics; or, Control and communication in the animal and the machine*. New York: Wiley.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin and Review*, 9, 625–636.

Wilson, R. A. (2004). *Boundaries of the mind*. Cambridge: Cambridge University Press.

Young, J. Z. (1964). *A model of the brain*. Oxford: Oxford University Press.

Cambridge University Press
978-0-521-84832-9 - The Cambridge Handbook of Situated Cognition
Edited by Philip Robbins and Murat Aydede
Excerpt
More information

CHAPTER 2

Scientific Antecedents of Situated Cognition

William J. Clancey

Introduction

In the late 1980s, an artificial intelligence (AI) researcher trying to untangle controversies about the nature of knowledge, memory, and behavior would have been surrounded by perplexed computer science and psychology colleagues who viewed situated cognition ideas as fool's gold – or even suggested that those ideas threatened the foundations of science itself. But scholars knew the concepts and methods of situated cognition from a much broader and deeper background, one that embraced Dewey's (1896) early objections to stimulus-response theory, Wittgenstein's (1953/1958) notions of family resemblances and language games, Gibson's (1966) affordances, Bateson's (1972) ecology of mind, Polanyi's (1966) tacit knowledge, von Bertalanffy's (1968) general systems theory, and so on, in the work of dozens of well-known figures in philosophy, psychology, linguistics, ethology, biology, and anthropology. Indeed, throughout science, including AI itself during the 1960s and 1970s, one finds at least the seeds for a situated theory of cognition. This chapter provides a broad historical review of the scientific antecedents of situated cognition; Gallagher (this volume) details philosophical aspects.[1]

What idea could be so general that it applies to every scientific discipline? And why was this idea so controversial in the AI community? What aspect of cognition relates the social sciences, linguistics, pedagogy, animal cognition, and evolutionary biology to neural theories of perception, learning, and memory? What problematic aspects of cognition in AI research foreshadowed the development of a situated epistemology? These are the topics I discuss in this chapter. In large part, the story centers on particular scientists, but I present the central ideas as crosscutting themes. These themes reveal that human cognitive processes are inherently social, interactive, personal, biological, and neurological, which is to say that a variety of systems develop and depend on one another in complex ways. Many stories can be told about these interrelations. The concepts, perspectives, and theoretical frameworks that influenced the situated cognition of the 1980s are still alive in