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Introduction

Embodiment in the field of cognitive science refers to understanding the role of an agent's own body in its everyday, situated cognition. For example, how do our bodies influence the ways we think and speak? Consider the following narrative written by a 23-year-old woman, Sandra, who was asked to describe a recent, important life event. Sandra began her narrative by noting that she was engaged to be married to an older man who worked in the computer industry in northern California. Quite recently, Sandra's fiancé asked her to sign a prenuptial agreement and this request evoked many feelings that Sandra struggled to deal with.

I know that I shouldn't be so naive about this sort of thing, but when he presented me with a draft of the agreement, it was so formal and legal and felt so cold to me that I just broke down crying. I simply couldn't stand to see our future relationship be reduced to questions of money. It seemed like Barry didn't trust me, or that he lacked faith in our future. I had always thought that we were in this together, going forward as partners as we started dating, got serious, then engaged, and hopefully soon married. Now my parents want me to consult with a lawyer to insure I don't get screwed by the pre-nup.

I'm trying hard to find the right balance between understanding Barry's needs to protect himself and my own needs for emotional security . . . I'm trying to be flexible about the whole thing . . . I love Barry and I know he loves me and I wish that the feeling of love would be enough to sustain us through anything. But the idea of getting divorced, even before we have been married, makes me ill. Everyone tells me that I'll get over this and that doing the pre-nup is probably the right thing to do. That may be so. The wedding is in August. Hopefully by that time, I'll be mellow about what we're going through right now.

This narrative is not particularly remarkable in terms of how Sandra described her recent experience. However, a closer look at what is said reveals how various embodied experiences help structure the narrative. For example, Sandra commented early on that "I couldn't stand to see

our future relationship be reduced to questions of money," referring to the physical experience of standing, or failing to remain standing, to describe how she felt about her relationship becoming so centered on money issues. Later on, Sandra said, "I had always thought that we were in this together, going forward as partners as we started dating, got serious, then engaged, and hopefully soon married." At this moment, Sandra clearly talked of her relationship in terms of being physically together with her boyfriend as they started out on a journey, beginning when they first began dating, soon traveling to the point of getting serious, and then moving forward along a path toward the eventual destination of marriage.

Sandra also noted her struggle "to find the right balance between understanding Barry's needs to protect himself and my own needs for emotional security." This emotional experience is referred to metaphorically, as if Sandra were physically balancing two opposing weights while trying to remain upright. As she worked to come to terms with her fiancé's request for a prenuptial agreement, Sandra was "trying to be flexible about the whole thing," again showing that she is conceptualizing her emotional experience as if her body must adjust to remain flexible in order not to be injured when confronted with physical burdens. Finally, Sandra hoped for her wedding that "by that time, I'll be mellow about what we're going through right now," referring to the physical obstacle that she and her fiancé were struggling to overcome along the path of their relationship journey.

Sandra's narrative illustrates how the ways we think about our experiences may be shaped by embodiment. She specifically talked of her mental/emotional experiences in terms of recurring patterns of embodied action (e.g., standing, being flexible, movement along paths toward goals, remaining balanced). Sandra was likely not conscious of the embodied character of her words, and readers probably do not think of her emotional experiences as specific embodied actions. Yet Sandra's description of her emotional experiences in terms of embodied action is not a linguistic accident, but demonstrates how embodiment provides the foundation for how people interpret their lives and the world around them.

What must a body be like for it to support cognition, language, and consciousness? Did Sandra's embodied experience shape the way she thought about particular topics, or did she merely talk that way? One of the traditional beliefs in the cognitive sciences is that intelligent behavior, including the ability to perceive, think, and use language, need not arise from any specific bodily form. Thermostats, computers, robots, and brains in vats may all, under the right circumstances, exhibit sophisticated cognitive skills. Under this view, cognitive systems are best characterized in terms of their functional states (i.e., their logical and computational processes) without concern for how these states are physically realized (i.e., as human brains, silicon chips, or robots). The building materials that shape

the contents of mental life simply do not matter. Minds may be realized in flesh, silicon, or even cream cheese (Putnam, 1975). To be in a specific mental state is simply to be in a physical device of whatever type satisfies a specific formal/functional description.

This traditional conception of mind and body has imposed serious limitations on the scholarly study of mental life in cognitive science. Although psychologists and others readily admit that much knowledge is derived from sensory perception, few scholars, until recently, have emphasized the importance of kinesthetic action in theoretical accounts of how people perceive, learn, think, experience emotions and consciousness, and use language. This book advances the idea that the traditional disembodied view of mind is mistaken, because human cognition is fundamentally shaped by embodied experience. My aim is to describe the way in which many aspects of cognition are grounded in embodiment, especially in terms of the phenomenological experience of our bodies in action. Embodiment may not provide the single foundation for all thought and language, but it is an essential part of the perceptual and cognitive processes by which we make sense of our experiences in the world.

Why has cognitive science been so neglectful of embodiment in constructing theories of perception, cognition, and language? The denial of the body in consideration of human thought has been part of the Western intellectual tradition since the time of the ancient Greeks. Perhaps the best voice for this earlier view was Plato, as shown in the following dialogue from the "Phaedo":

> All these considerations, said Socrates, must surely prompt serious philosophers to review the position in some such way as this . . . So long as we keep the body and our soul contaminated with this imperfection, there is no chance of our ever attaining satisfactorily to our object, which we assert to be the truth. . . . The body fills us with loves and desires and fears and all sorts of nonsense, with the result that we literally never get an opportunity to think at all about anything . . . That is why, on all these accounts, we have so little time for philosophy. . . . It seems, to judge from the argument, that the wisdom which we desire and upon which we profess to have set our hearts will be attainable only when we are dead . . . It seems that so long as we are alive, we shall continue closest to knowledge if we avoid as much as we can all contact and association with the body, except when they are absolutely necessary, and instead of allowing ourselves to become infected with its nature, purify ourselves from it until God himself gives us deliverance. (Hamilton & Cairns, 1961: 49)

Plato viewed the body as a source of distraction in intellectual life that must be eradicated in the practice of philosophy. Separation of the mind and body and the hierarchical ordering of mind over body haunt the history of Western philosophical accounts of knowledge from Plato, Aristotle, and Augustine through to Descartes and Kant. For example, in early Christian writings, bodily sensations and desires were rivaled in contests against a

higher form of Truth, or closeness to God. As St. Augustine wrote in the fifth century, "More and more, O Lord, you will increase your gift in me, so that my soul may follow me to you, freed from the concupiscence which binds it, and rebel no more against itself" (Augustine, 1961: 234). Augustine fixed the body as a source of sin, weakness, and the measure against which the strength of his will toward God is knowable.

In the 17th century, Rene Descartes' struggle with a purely material body and a perfectly insubstantial mind led him to propose that the body is, in fact, an idea in the mind (Descartes, 1984, 1985). The body's materiality, along with other objects that are impressed upon body substances, is a literalization of this idea in our experience. When we pay attention to it, the body materializes, and we become aware of the body as an object. However, as our attention centers on other things, or on thought itself, the body disappears.

Mental phenomena, according to Descartes, have no place in the quantifiable world of physics, but have a completely autonomous status: "I am a substance the whole nature or essence of which is to think, and which for its existence does not need any place or depend on any material thing" (Descartes, Discourse, Part IV). Descartes distinguished, then, between physical substances ("res extensa"), which can be measured and divided, and thinking substances ("res cogitans"), which are unextended and indivisible. The human body, including the brain and nervous system, belongs to the first group, whereas the mind, including all thoughts, desires, and volitions, belongs to the second.

Cartesian dualism arose from Descartes' claim that he could doubt the existence of physical objects, including his own body, but not the existence of his thoughts or thinking. Although Descartes worried about possible interactions of mind and body, Cartesian dualism evolved into an epistemological tradition that separated the mind as rational, thinking, immaterial, and private from the body as an irrational, corrupt, and physical substance that merely provided public, physical exertion on the material world. This bifurcation of the person into mind and body has subsequently given rise to many other dualisms, including subjective as opposed to objective, knowledge as opposed to experience, reason as opposed to feeling, theory as opposed to practice, and verbal as opposed to nonverbal. Cartesianism has also led to the romantic view of the body as the last bastion of what is natural, unspoiled, preconceptual, and primitive in experience. Bodily movement is viewed as behavior, with little relevance to language, thought, or consciousness, and not as meaningful action.

The Western tradition since Descartes has generally assumed that the body is a solid object and the self, in particular the mind, is an ethereal subject mysteriously infused into the body object. Throughout history, the mind has been modeled as a series of different material objects (e.g., a hydraulic machine, a telephone switchboard, a hologram, a digital computer).

Cognitive science, as an interdisciplinary research enterprise, came into being in the 1950s with the rise of the MIND IS A COMPUTER metaphor, which resulted from technological advances in computing machinery. Alan Turing (1950) outlined a method for assessing the question "Can machines think?" Following in Descartes' footsteps, Turing emphasized the importance of drawing a "fairly sharp line" (p. 434) between a person's physical capacities and his/her intellectual abilities. Turing asked us to consider a scenario that included three people – a man (A), a woman (B), and an interrogator of unspecified sex (C). The interrogator was in a separate room from the man and the woman, and the interrogator's task was to determine which of the two was a man and which was a woman on the basis of their written answers to certain questions (e.g., "What is the length of your hair?"). It is A's task to confuse the interrogator and B's task to help. The test proper comes into play by swapping the man (A) with a machine. If the interrogator makes the same set of judgments, deductions, and guesses after the swap as before (i.e., the interrogator is unable to distinguish the machine's answers from the man's answers), then the machine has passed the "Turing test." The machine whose behavior is indistinguishable from the intellect of the man is the machine that thinks.

Cognitive science models of intelligent human activity have mostly continued to assume, like Turing, that cognition is autonomous, logical, and disembodied. In his history of cognitive science, Gardner (1985) claimed that the exclusion of the body was, in fact, a benign methodological decision: "Though mainstream cognitive scientists do not necessarily bear any animus against the affective realm, against the context that surrounds any actor or thought, or against historical or cultural analyses, in practice they attempt to factor out these elements to the maximum extent possible . . . This may be a question of practicality: if one were to take into account these individualizing and phenomenalistic elements, cognitive science might well become impossible" (p. 41).

Some cognitive scientists question whether the exclusion of the phenomenological body, along with other aspects of experience such as emotion and consciousness, is merely a methodological issue, and not really constitutive of what cognitive scientists believe is essential about cognition. Of course, many scholars now try to avoid the strict separation of mind and body assumed by Cartesian dualism. The most popular strategy, especially in recent decades, has been to reduce mental events to brain processes and replace internal explanations with instrumental ones. In some cases, the reduction of mind to brain carries with it the reduction of body to brain. Neuroscientists, for instance, seldom acknowledge the role played by the body as a whole in the cognitive operation of the brain. The body is reduced to its representation in the somatosensory cortex and is considered important only to the extent that it provides the raw sensory input required for cognitive computations. In other cases, the body is first reduced to the

mind, and then reduced to the brain. This is especially true in psychology, where the body is first treated as an intentional object (i.e., an image, a mental representation) and then reduced to neural computations.

Contemporary philosophers argue over whether a physical body is necessary for knowledge and cognition, often by considering the implications of different thought experiments in which the mind may be divorced from critical aspects of bodily experience. For instance, consider the following scenario:

> Imagine a brilliant neuroscientist named Mary, who has lived her entire life in a room that is rigorously controlled to display only various shades of black, white, and grey. She learns about the outside world by means of a black/white television monitor, and being brilliant, she manages to transcend these obstacles. She becomes the world's greatest neuroscientist, all from within this room. In particular, she comes to know everything there is to know about the physical structure and activity of the brain and its visual system, of its actual and possible states. (Churchland, 1985: 22)

Philosophers argue, based on examples like the above, over whether qualia (i.e., the phenomenal character of our experience), such as one's subjective sensations of color, must be mental states that are causally related to the neurophysiology of the brain (see Churchland, 1984; Jackson, 1982, 1986). These scenarios, however, dramatically fail to recognize the need for a real living body in knowing about the world. There is no acknowledgment of Mary as a living person, made of flesh, blood, and bone, who moves and has awareness of the felt qualities of her own actions. Mary's first-person experiences of her own body in relation to the environment provide knowledge that is "qualitatively incommensurate" with whatever may be happening in her own brain, or anyone else's (Sheets-Johnstone, 1999: 167). Mary learns about qualia because she subjectively experiences them through her own bodily actions. Knowledge of a set of abstract propositions, such as Mary's understanding of the neurophysiology of color vision, means nothing unless a person experiences in some embodied sense the physical world to which these propositions refer (Sheets-Johnstone, 1999).

Cognitive psychologists, like many philosophers, often fail to recognize the significance of embodied action in the study of human mental life. Most experimental investigations of perception and cognition occur in laboratory situations where a person passively observes stimuli and then responds in some specified manner to what has been presented. In some instances, the person is physically restricted in his or her movements (e.g., head rests are used in psychophysical experiments). In cases where the participant must move to respond to stimuli, such as having to push a button or speak aloud, psychologists work hard to eliminate the movement from their theoretical understanding of the processes involved in perception and cognition. Cognitive processes, especially, are viewed as strictly

mental phenomena that have little to do with embodied experience. The body is the vessel for the mind and brain, but has negligible importance in characterizing the essence of mental life.

However, the situation is now changing. Consider just three examples of how psychologists now pay attention to embodied action when studying different cognitive phenomena. First, the classic empirical work on mental imagery investigates possible correspondences between mental imagery and visual perception. For example, participants in one classic study were presented with two-dimensional drawings of pairs of three dimensional objects. The participants' task was to determine whether the two represented objects were identical except for orientation (Shepard & Metzler, 1971). Some of the figures required rotation solely within the picture plane, whereas others required rotation in depth ("into" the page). The general result was that, whether for two- or three-dimensional rotations, participants seemed to rotate the objects mentally at a fixed rate of approximately 60 degrees/second. For many years, psychologists assumed that cognitive abilities, such as those observed in mental rotation studies, demonstrate the tight link between visual perception and mental imagery. Although numerous studies examine people's kinesthetic and motor imagery, scholars traditionally have not searched for explicit relations between kinesthetic activity and mental imagery.

However, recent work suggests that many aspects of visual and motor imagery share a common representational, and possibly neuropsychological, substrate. Various studies demonstrate that the ability to transform mental images is linked to motor processes, so that rotating one's hands in the direction opposite to the required mental rotation slows down the speed of mental rotation (Wexler, Kosslyn, & Berthoz, 1998). Researchers now claim that "visuomotor anticipation is the engine that drives mental rotation" (Wexler et al., 1998). Under this view, similar mechanisms drive both visual image transformation and the production of embodied movements. The ability to plan movements as simulated actions, and not as actual motor plans, may be the common element underlying embodied action and mental imagery performance (Johnson, 2000). These new developments in cognitive psychology illustrate how correcting for a previous neglect of embodied experience in experimental studies leads to a richer picture of the importance of embodiment in human cognition.

Psycholinguists have also slowly begun to seek out the embodied foundation of linguistic structure and meaning. Recall Sandra's earlier comment in response to her fiancé's request for a prenuptial agreement that "I couldn't stand to see our future relationship be reduced to questions of money." Why is it that Sandra used the word "stand" to refer to an abstract, mental experience of her adjusting to her fiancé's demand? Traditional studies on how people process ambiguous, or polysemous, words such as "stand" generally assume that each sense of a word is listed as part of

its entry in the mental lexicon. For example, do people immediately access all the possible senses for the word "stand," with context determining which meaning is appropriate afterward? Or does context constrain lexical access so that only the correct meaning of "stand" is accessed during immediate utterance interpretation? These empirical questions have been studied extensively (Gorfein, 2001).

Psycholinguists rarely ask whether people have intuitions about why "stand," or any polysemous word, has the variety of meanings it does. Recent studies, however, demonstrate that people's intuitions about the meanings of "stand" are shaped by their embodied experiences of standing (Gibbs, Beitel, Harrington, & Sanders, 1994). Thus, people tacitly recognize that Sandra's use of "stand" has a metaphorical meaning that is related to their embodied experiences of struggling to remain physically upright when some physical force acts against them. People's understandings of linguistic meanings are not divorced from their embodied experiences, but rather are fundamentally constrained by them in predictable ways.

Following Piaget's early writings, developmental psychology has also started to meaningfully explore how embodied action may underlie children's acquisition of perceptual/conceptual knowledge. For example, infants' interest in things that move assists them in understanding some cause-effect relations in the physical world. Sophisticated studies indicated that infants 12 months old and younger are capable, in the right setting, of making causal attributions to the behavior of objects they see in the world (Gergely, Nadasdy, Csiba, & Biro, 1995; Spelke, Philip, & Woodward, 1995). The infant's developing sensitivity to causal relations may underlie the acquisition of a concept for agency (i.e., things move because of internal forces or human intentions).

These studies, however, despite their brilliance, situate the child as a passive observer who learns to reason about the physical world by visual inspection of real-world events. Several experiments now demonstrate the importance of the child's bodily exploration of the physical world in learning about objects and their behaviors (Adolph, 1997, 2000; Bertenthal, Campos, & Kermoian, 1994; Hertenstein, 2002; Needham, Barrett, & Peterman, 2002). This empirical work suggests that many basic concepts may arise from rudimentary bodily actions and young children's felt experiences of them. Causation and agency, for example, may be rooted in infants' phenomenological sense of their own bodies' interactions with objects and other people. Even before infants possess any ability to physically manipulate objects with their hands and feet, they directly experience cause and effect from the movement of their lips, tongues, and mouths during breastfeeding, or from chewing food, which transforms it to something that can be swallowed easily. An encouraging trend in developmental psychology is greater attention given to infants' phenomenological experience in relation to cognitive growth.

These brief examples illustrate how looking for embodied action in thought and language may provide a different picture of human cognition than has traditionally been assumed within cognitive science. Much recent work in cognitive science views embodiment as a matter of brain states and neural activity. We have indeed learned a great deal from these neuroscientific studies. However, as Roger Sperry noted over sixty-five years ago, "An objective psychologist, hoping to get at the physiological side of behavior, is apt to plunge immediately into neurology trying to correlate brain activity with modes of experience. The result in many cases only accentuates the gap between the total experience as studied by the psychologist and neuronal activity as analyzed by the neurologists. But the experience of the organism is integrated, organized, and has its meaning in terms of coordinated movement" (1939: 295).

The psychologist Scott Kelso more recently suggested, "It is important to keep in mind . . . that the brain did not evolve merely to register representations of the world; rather, it evolved for adaptive actions and behaviors. Musculoskeletal structures coevolved with appropriate brain structures so that the entire unit must function together in an adaptive fashion . . . it is the entire system of muscles, joints, and proprioceptive and kinesthetic functions and appropriate parts of the brain that evolve and function together in a unitary way" (1995: 268).

The brain is certainly part of an integrated dynamic system devoted to the moment-by-moment embodied dynamics of everyday life. Viewing the brain simply as an information-processing or computational device, as the center of cognition, ignores the centrality of animate form in human thought (Sheets-Johnstone, 1999).

This book describes the ways that perception, concepts, mental imagery, memory, reasoning, cognitive development, language, emotion, and consciousness have, to varying extents, groundings in embodiment. My strategy in exploring the significance of embodiment in the study of these topics adopts what may be called the "embodiment premise":

> People's subjective, felt experiences of their bodies in action provide part of the fundamental grounding for language and thought. Cognition is what occurs when the body engages the physical, cultural world and must be studied in terms of the dynamical interactions between people and the environment. Human language and thought emerge from recurring patterns of embodied activity that constrain ongoing intelligent behavior. We must not assume cognition to be purely internal, symbolic, computational, and disembodied, but seek out the gross and detailed ways that language and thought are inextricably shaped by embodied action.

The key feature of this premise is the idea that understanding the embodied nature of human cognition demands that researchers specifically look for possible mind-body and language-body connections. Understanding embodied experience is not simply a matter of physiology or kinesiology

(i.e., the body as object), but demands recognition of how people dynamically move in the physical/cultural world (i.e., the body experienced from a first-person, phenomenological perspective). The mind (its images, thoughts, representations) is created from ideas that are closely related to brain representations of the body and to the body's continued activities in the real world.

Fortunately, there is an accumulating body of empirical evidence showing how embodied activities shape human cognition. In the spirit of cognitive science, this "empirical" evidence includes data collected from controlled laboratory studies, naturalistic field observations, neuropsychological case studies, linguistic research, artificial intelligence (and artificial life) modeling, and various phenomenological studies and reports. To be sure, many of the scholars whose studies are described here may not entirely agree with my interpretation of their work as support for "embodied" cognition. Some of these disagreements center around what is meant by the terms "embodied" and "embodiment." I argue that "embodiment" may refer to, at least, three levels of personhood (see Lakoff & Johnson, 1999): neural events, the cognitive unconscious, and phenomenological experience. Although amazing advances have been made in understanding neural processes, insignificant attention has been given to people's phenomenological experience in explaining many aspects of perception, cognition, and language. I address this problem in the pages that follow.

At the same time, special emphasis will be given in the following chapters to two important developments in cognitive science. The first is the approach to cognition known as dynamical systems theory. Dynamical approaches emphasize the temporal dimensions of cognition and the ways in which an individual's behavior emerges from interactions of brain, body, and environment. Simple and complex behavioral patterns are higher-order products of self-organization processes. Virtually all living organisms self-assemble, or are self-organizing systems, "as emergent consequences of nonlinear interaction among active components" (Kelso, 1995: 67). Self-organized patterns of behavior emerge as stable states from the interaction of many subsystems. Yet the emerging higher-order behavior is also capable of "enslaving" lower-level components in such a way that behavioral patterns can often be described by relatively few dimensions. Much of the emphasis, then, in dynamical systems theory is on the structure of spaces of possible behavioral trajectories and the internal and external forces (i.e., couplings between brain, body, and world) that shape these trajectories as they unfold. More specifically, dynamical systems theory is a set of mathematical tools that can be applied to characterize different states of the system as these evolve in time. In this way, a dynamical view aims to describe how the body's continuous interactions with the world provide for coordinated patterns of adaptive behavior, rather than focusing on how the external world become represented in the inner mind.