

I. The Cognitive foundations of language

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1. Mind and body

There is a long history in philosophy of asking what the relationship is between the mind and the body. This question is as relevant to language as to any cognitive function, since language is at once a mental and a corporeal phenomenon. But perhaps this issue becomes even more relevant for language, a higher cognitive function that arguably distinguishes humans from other animals.

In general, the body appears to matter to the mind in a variety of ways. The concepts we have and the meanings we convey through language are not unrelated to the experiences we have moving our bodies or perceiving the world. But this leaves ample room for uncertainty. Exactly what impact do our bodies have? Are they important for how we learn new language and concepts? Or perhaps we use our bodies in an online fashion to make sense of even conventional language and concepts. Either or both of these may be true not only for things that are transparently related to bodily experiences, like motor actions and visual events, but also for concepts that are abstract in that their relation to the body is more tenuous – things denoted by words like *justice* or *truth*.

Since the 1980s, the idea that the body matters to the mind has been known as *embodiment* (Rosch and Lloyd 1978; Johnson 1987; Varela et al. 1991; Gibbs 2005; for an early precursor, see Merleau-Ponty 1945). This has been a central, orienting concept in cognitive linguistics research since its inception. But as big concepts often do, embodiment means different things to different researchers and its use has changed over time. This chapter begins by outlining the historical conceptions of embodiment in cognitive science. It then describes some of the ways that embodiment has been used in cognitive linguistics, and ends by anticipating the directions that linguistic embodiment research is currently moving in.

2. A brief history of embodiment

2.1. Dualism, monism, and everything in between

In principle, there are different ways the mind could relate to the body, and many of these possibilities have their own champions, arguments, and literatures. The strongest

imaginable positions stand in contrast to one another. It could be on the one hand that there is no meaningful relation between the mind and body; the *dualist* position holds that the mind is of qualitatively unique stuff, irreducible to the material realm where the body lives. Or on the other hand, it could be that the mind and body are really one and the same; the strongest *monist* position argues that everything we want to know about the mind can be reduced to physics and explained away in material terms (this proposition therefore sometimes goes under the banner of *eliminative materialism*).

The vast majority of work in cognitive science, and cognitive linguistics as a sub-discipline, resides somewhere between these two extremes. At the time of the writing of this chapter, it's overwhelmingly clear that the body matters in profound ways to how the mind works. In the most banal way, for instance, having an intact, working brain is a pre-requisite to human cognition. Things without brains, like brooms and rocks, do not think, and they do not have language. Somewhat more informatively, the limits and nature of the brain's computational capacity shape what the mind can achieve; human language for instance requires a human brain – an elephant brain will not suffice.

Yet at the same time, it's clear, at least for the purpose of conducting meaningful and useful science, that we would be ill-served to throw out everything we want to know about the mind in an effort to reduce it to other, lower, physical levels of explanation. Even if we believed that in principle everything about human language could be reduced to the biology, chemistry, and ultimately the physics of individuals and the world (and many researchers do hold this non-eliminative materialist position) it currently appears that it is still useful to have a higher level of enquiry that addresses the mind and mental constructs. This is a level at which we can ask questions, formulate theories, and seek answers about how the mind works. For example, even if, ultimately, cognitive-level concepts like CONCEPT or WORD are merely epiphenomenal – even if they can be explained away in terms of underlying biochemistry and physics, it still makes sense for us, at least for the time being, to use the constructs of concepts and words in our science. That's because we're interested in how people learn words, how we figure out what they mean, how their meanings relate to concepts, and so on.

So it's a tacit assumption in most (but not all) of cognitive science that the parts and processes proper to what we think of as the mind need to be explained, and that the brain and body are one possible source of explanation. And because the brain and body seem deeply related to cognition, much of the work in cognitive science asks questions about the extent to which and the ways in which the particularities of the body, including the brain, affect the functioning and properties of the mind, or even, on some accounts constitute the mind themselves. This is the issue of *embodiment*.

2.2. Embodiment in cognitive science

There are roughly as many definitions of *embodiment* as there are people who use the word. I say "roughly" because many people who use the word seem to use it in multiple ways, while others may not have a particularly well formed idea of what they intend it to mean. In general, *embodiment* seems to be used to mean something about how the mind relates to the body. But this relation can come in many guises, and embodiment can signify any of the following things (see Wilson 2002; Ziemke 2003; and Ziemke et al. 2007 for much more thorough reviews):

- There are properties of the mind that can only be explained by reference to the brain or body
- The mind is not just generalized software, but is software than can be run on only one type of hardware, namely the brain
- Individual differences in brain and body produce individual differences in the mind
- For the mind to function, the organism must have a body, including but not limited to a brain (so a brain in a vat wouldn't have the same properties as a brain in a body)
- An individual's experience (presumably in his/her brain and body) are critical to the individual's mind
- The mind is not limited to brain functioning, but also extends to the use of other parts of the body (so that cognition isn't just between the ears)
- The mind is not limited to brain and body functioning, but also extends to the environment in which a person is situated, including other individuals or artifacts.

The version of embodiment that is most prevalent in the cognitive linguistics literature is this particular one:

the structures used to put together our conceptual systems grow out of bodily experience and make sense in terms of it; moreover, the core of our conceptual systems is directly grounded in perception, body movement, and experience of a physical and social nature. (Lakoff 1987: xiv)

There's a lot built into this definition. But there are two key types of embodiment that it hints at. The first argues that the concepts or cognitive machinery we use for various cognitive behaviors, like reasoning, using language, and so on are built, presumably over the course of the development of an individual, from experiences that the individual has, which may be perceptual, motor, or affective in nature. This shapes the properties of those components of the cognitive system. This developmental notion of embodiment is more clearly distinguished in Lakoff and Johnson (1999).

The claim that the mind is embodied is, therefore, far more than the simple-minded claim that the body is needed if we are to think. [...] Our claim is, rather, that the very properties of concepts are created as a result of the way the brain and body are structured and the way they function in interpersonal relations and in the physical world. (Lakoff and Johnson 1999: 37)

A second possibility is that the links between concepts on the one hand and the perceptual, motor, and affective experiences the individual has had are not lost over the course of development – they continue to play a role in (“grounding” or “making sense of”) the use of concepts. This second, online position is described as follows:

In an embodied mind, it is conceivable that the same neural system engaged in *perception* (or in bodily movement) plays a central role in *conception*. That is, the very mechanisms responsible for perception, movements, and object manipulation could be responsible for conceptualization and reasoning. (Lakoff and Johnson 1999: 38)

Although they seem superficially similar, these two possible relations between language and perception or action come with distinct causal and mechanistic claims. Each requires

different sorts of evidence and if true has different consequences for what aspects of cognition embodiment is important to, and in what ways. I'll tease some of these differences apart in the next three sections, which cover three major phases of embodiment research in Cognitive Linguistics.

3. The analytical phase

Cognitive Linguistics has used the notion of embodiment to explain facts about language since its inception. There have been three distinct phases in the application of the idea of embodiment to empirical work on language and cognition. The first, discussed in this section, was *analytical* in that it involved linguists – inspired by work in cognitive psychology – looking for evidence of how the conceptual resources that underlie language use might be embodied through analysis of language. Work in this stage produced results that did not speak much to mechanisms, and as a result were equally compatible with the developmental and online types of embodiment. The second phase, discussed in the next section, is the *process* phase, which involved refinement of the online version of embodiment in a way that has generated a new theoretical framework, and inspired a substantial body of empirical work. And the third phase, which the field is currently moving into, is discussed in section 5. This is the *function* phase, in which researchers are refining their tools in an effort to determine exactly what embodiment does for specific aspects of language use and other cognitive operations.

3.1. Inspiration from cognitive psychology

The earliest self-consciously cognitive linguistic efforts were inspired by neighboring cognitive psychology and cognitive anthropology results suggesting a variety of ways in which language was not independent of the body. For instance, Eleanor Rosch's work on category structure provided evidence that the way we split up the world linguistically depends on the way we interact with it. This is perhaps most obvious in her work on basic level categorization (Rosch et al. 1976). She found that the words people are most likely to use in neutral contexts to describe things (e.g., *tree* for urban North Americans, as opposed to the more specific *pine* or more general *life form*) collect a whole host of properties. Like *tree*, these Basic Level terms tend to be short, learned early, faster to access, among other features. Critically, the taxonomical level that tends to be Basic appears to be dependent on human bodily interactions with the world. The basic level for objects appears to be best explained as the highest level of categorization that shares a common mental image and interactional affordances.

Another line of Rosch's work, on prototypicality, was similarly inspirational to early cognitive linguistics in terms of its contributions to the idea of embodiment (Rosch 1978). Rosch found that not all members of categories are equivalent in terms of people's mental representations. Americans treat robins as better examples of the category bird than they do ostriches, not only when explicitly asked to judge, but also when their reaction time to decide whether each category member is in fact a category member is measured. And there are even asymmetrical effects of prototypicality in reasoning – people are more likely to infer that a property of robins is true of ostriches than the reverse. Again,

prototypicality seems to suggest that mental categories are embodied since they depend on our interactions with the world – the prototypical bird varies as a function of exposure, so people with different life histories have different mental categories.

Results like Rosch's inspired cognitive linguists to look, using the tools of analytical linguistics, for places where linguistic distributions appeared to depend on embodied knowledge. There have been five major lines of work to pursue this goal, each of which is addressed in turn below.

3.2. Embodied syntax

One of the central features of human language is that it displays structure at multiple levels (phonological, morphological, syntactic) that goes beyond mere sequence. Humans seem particularly well equipped to learn and use language with all its complexities, and many other animals do not. Consequently, it becomes very interesting to ask what the human capacity for complex linguistic structure is like. Linguistics in the second half of the 20th century was particularly oriented towards syntax, so a great deal of work during this period focused on the nature of the human cognitive capacity for structure at this level.

Beginning in the 1960s, the mainstream Generative (or Chomskian) approach to language posited that syntax is an informationally encapsulated module of the mind to be explained solely on the basis of internal computational principles. This product of a philosophical orientation towards neo-Cartesian dualism led many linguists to reject the possibility that the idiosyncratic and physically constrained working of the brain, the body, or experience could be relevant to the pinnacle capacity of human minds: abstract syntax.

But early cognitive linguists, as well as functionalists, attempted to demonstrate ways in which syntactic knowledge is sensitive to the body and bodily experience – in particular, ways in which meaning actually matters to syntactic form. This was seen as a type of embodiment, since the goals, intentions, knowledge, and beliefs of the individual can't help but be shaped by individual experience, and to the extent that they in turn affect grammar, that would mean that grammar depends on individual world experiences.

A good deal of the argument hinges on what, exactly, constitutes syntactic knowledge per se. At the time, much of the field held up grammaticality judgments as a valid measure of what language users know, and so early Cognitive Linguistics work aimed to determine whether these judgments reflected knowledge that couldn't be syntax-internal, but had to do with the meaning the language user wanted to convey. Consider, for instance, an utterance like *Rupert sneezed me the peanuts*. Determining whether this string of words forms a grammatical sentence or not depends entirely on how plausible the comprehender thinks it is that Rupert could transfer peanuts to someone through sneezing. It might become more plausible if we know that Rupert is not a person but rather an elephant, for example. When meaning intrudes on grammaticality, it is impossible to characterize syntax as a strictly autonomous system (for the full version of this argument, see Goldberg 1995).¹

¹ Some linguists deal with this issue by making a distinction between grammaticality (a theory-internal construct) and acceptability (the judgments language users make), and acknowledge that the latter can be influenced by semantic plausibility but reject this possibility for the former (Chomsky 1965).

Other work in Cognitive Linguistics tried to derive the form of syntactic constructions directly or indirectly from the (embodied) functions people put them to. The idea here was that if the principles that govern syntactic structure can be shown to be syntax-external, then again individual world experiences, as channeled through the body, matter to linguistic knowledge. One well known example is the case of deictic there-constructions, as in *There's the restaurant we were looking for* (Lakoff 1987). Deictic there-constructions behave differently from any other constructions in the language. They start with a deictic demonstrative *there* instead of a subject, have a restricted range of verbs they can use (basically just the copula, and not in the past tense), and the verb is followed by an apparent subject that has a range of restrictions on it. Lakoff (1987) argues that this unique syntactic patterning is due to the unique function it has: linguistically pointing things out in the situated context of use. To the extent that conventional linguistic patterns can be explained as consequences of the functions they're put to, this means that syntax is again not encapsulated from the experiences a language user has had using that expression for embodied communication.

Complementary lines of work on Cognitive Grammar (Langacker 1987, 2002) and Construction Grammar (Goldberg 1995) advance two related ways that embodiment could have an impact on language. The first is the idea that the operations that an individual performs while using language have two facets – one part applies to the form, aggregating and ordering a string, but a second part operates in parallel over its meaning. Researchers in these traditions point to (sometimes subtle) differences in meaning, function, or use across different syntactic forms that may or may not have been previously analyzed as notational or surface variants of one another. For instance, the English double-object construction (as in *The mayor tossed his secretary the keys*) appears to bear a slightly different meaning from the English caused-motion construction (*The mayor tossed the keys to his secretary*), but this is best illuminated by the cases in which only the caused-motion is licit (*The mayor tossed his keys to the floor*) and the double-object version is not (**The mayor tossed the floor his keys*). In its strongest form, the hypothesis that any difference in form entails a corresponding difference in meaning is the Non-Synonymy Principle (Goldberg 1995), and it remains controversial, not in the least because there are different ways to define what synonymy and meaning mean. But to the extent that form and meaning constraints operate in parallel to constrain what is and what is not a licit utterance in a language, it's again impossible to hold syntax apart as a function immune from the body's effects.

The second way in which Cognitive Grammar in particular contributes to embodiment is through the importance placed on individual experience; the idea that language is learned bottom-up, such that individuals interacting with language (presumably in their bodies with their brains in the world) memorize and then schematize over useful and salient linguistic patterns. This is the idea of a usage-based model, which follows in the next section.

3.3. Usage-based models

As indicated by the cognitive psychology work that inspired early embodiment theory in cognitive linguistics, individual world experience might impinge on linguistic knowl-

edge. At the time when Cognitive Linguistics started to coalesce, Linguistics displayed a prevailing research focus (based on the Generative tradition) on universal aspects of linguistic knowledge (both across languages and across speakers of the same language) and on the categorical nature of linguistic knowledge, including categorical and grammatical knowledge (Harris 1995). The idea that individual experience – language use – might affect language knowledge, while not necessarily in opposition to the mainstream, generative view, certainly placed emphasis differently. Indeed, this was very much the argument given by generativists, like Fritz Newmeyer, who in a presidential address to the LSA famously argued that “grammar is grammar and usage is usage” (Newmeyer 2003). Certainly, no-one would argue that people’s knowledge is identical to what they say. The fact that I misspell the word *the* as ‘teh’ 25% of the time when typing quickly doesn’t entail that I think that the word is actually spelled ‘teh’ with probability 0.25. And the same is true of speech errors, disfluencies, and so on. However, the observation that people make and notice errors in production is not tantamount to endorsing a global distinction between knowledge and use, or competence and performance.

This intuition led many Cognitive Linguistics researchers to look to see whether aspects of language use affect undisputedly central representational aspects of language (see Divjak and Caldwell-Harris this volume). Are phonemes expressed in the same way in the same context, or does the frequency of the particular word they occur in affect the degree to which they will be reduced (Bybee and Scheibman 1999; Gahl and Garnsey 2004)? Does the frequency with which verbs occur in certain argument structure patterns predict how language comprehenders process those verbs in those argument structure constructions, and the perceived grammaticality of those verbs in those constructions (Ellis 2002; Gries et al. 2005)? These are questions about how use – typically operationalized in terms of frequency – affects linguistic knowledge.

There isn’t much debate any longer about how valid usage-based theories of language are, in large part because the point has been made. Much of the work now done in psycholinguistics takes for granted that knowledge about frequency, both the raw frequency of particular linguistic units or the strength of their tendency to co-occur with others, plays a role in the millisecond-by-millisecond processing of language. That is, it’s (nearly) universally accepted in psycholinguistics that people’s knowledge of language includes knowledge based on frequency and probability. This has in large part made the debate about use and knowledge irrelevant. People have knowledge of use. And it’s clear that if one’s theory of language knowledge can only include things that can’t be based on use, then this will cause one to define usage-based knowledge as qualitatively different from “core” language knowledge. But this is a debate about labeling and turf, not a real debate about the facts at hand. Use matters. And this means that this particular prong of embodiment work has come back with an answer in the affirmative. Yes, the experiences an individual language user has in the world matter to their linguistic knowledge (Dąbrowska this volume).

One particularly productive dimension of this usage-based approach has been in studies of early language development (Matthews this volume). What happens over the course of a child’s first several years of life, and how – if at all – does the body matter to what children learn, how, and when? Perhaps the most complete account of how children acquire language from an embodied perspective is provided in Tomasello (2009), who argues that children build language from the ground up, on the basis of their situated experiences with language in use. Critical in this account is an ability that

humans have (perhaps uniquely) to read the intentions of others – this is what allows the child to understand what a word refers to or what is intended with a speech act. Intention reading, on Tomasello’s account, depends in no small way on bodily interactions, including monitoring, following, and directing attention of others through eye gaze and through bodily gestures.

3.4. Image schemas

A core issue for cognitive linguistics is the nature of the mental representations that underlie meaning. Are they abstract and detached from embodied experiences? A sort of Language of Thought or Mentalese? Or are they fine-grained sensorimotor representations? One idea that has emerged in the cognitive linguistic literature falls between these alternatives, and proposes a kind of mental representation called *image schemas*. The basic notion of an image schema, as articulated by Johnson, is “[...] a recurring dynamic pattern of our perceptual interactions and motor programs that gives coherence and structure to our experience” (1987: xiv).

The idea is that recurring interactional experiences we have in our bodies serve to ground linguistic meaning, as well as conceptualization, reasoning, and so on. As a result, image schemas are thought to have certain features (see Hampe and Grady 2005). For one, they are generalized over many similar experiences, and are thus schematic (for instance, there wouldn’t be an image schema for a specific container but might be one for a container in general). And although they are schematic, they’re still believed to preserve both structural and perceptuomotor aspects of the specific experiences they schematize over. So an image schema for a container, for instance, would both specify the schematic relations between the inside, outside, portal, and boundary, all while doing so in a representational modality that preserves the continuous, perception-, action-, or affect-specific content that it derives from – visual details about what a container looks or feels like to interact with. Because image schemas are thought to preserve aspects of the experiences that they’re related to, they are characterized as grounded in those experiences. And because they are structured and schematic, they are believed to be usable for the normal sorts of things that concepts are used for, such as interfacing across cognitive systems, combining with one another, and being used in a displaced fashion.

The idea of image schemas has been influential in cognitive linguistics not least because of their perceived potential to explain distributional facts about language. To continue with the container example, there appear to be many words and grammatical structures that impose schematic constraints on how they can compose. For instance, the preposition *in* seems to evoke a schematic notion of containment such that the prepositional object can (at least in the concrete sense of *in*) be anything that can be construed as an instance of a container, from a garbage can to a galaxy. Image schemas are used to account for what *in* specifies its combinatorial affordances to be (it instantiates a container image schema and requires an object that can be a container). But because they’re taken as intrinsically grounded (the container schema is bound to the experiences of containers that it’s based on), image schemas are also taken as serving the function of grounding the meaning of words and their combinations.

3.5. Polysemy

Embodiment has also had an impact on the Cognitive Linguistic study of polysemy – understanding why words have which multiple meanings (see Gries this volume). Why are both the organ at the end of a human leg as well as the end of a bed called *foot*? Why does *hot* refer to both heat and spiciness? Why does the front of a clock share the name *face* with the front of an animal's head?

By the embodiment hypothesis, cases of polysemy like these might be explained by interventions of the human body on word meaning – interventions of different types in the three cases, each of which is merely a representative example of a much larger set of similar cases (Lakoff 1987). For instance, the foot of a bed is systematically co-located with human feet, and a process of metonymy might account for the extension of the word from the body to something body-adjacent (Barcelona this volume). The same process might account for the *head* of a bed. As for the case of *hot*, this word might refer not only to heat but also to spiciness because, given our bodies, the two experiences feel somewhat similar. Other examples of similarity in felt experience as potential mediator for polysemy include *over*, which although it prototypically refers to something that is located above another object in the vertical axis, can also refer to the relation where something merely covers a second object from view, even if they are arranged along a horizontal axis (as a picture can be placed *over* a hole in a wall to conceal it). And finally, we might use the word *face* for either a part of a clock or a part of a body because the former looks like the latter – humans for instance have a roundish thing centered at the top of their bodies, just as do clocks, especially analog ones. Words for body parts might get extended to things that look similar in other cases, like the *eye* of a hurricane or a potato, or the *shoulder* of a mountain.

Early Cognitive Linguistics was populated by many studies, exploring exactly these types of polysemy, trying to come to terms with the range and frequency of patterns like these within and across languages (Brugman 1981; Lindner 1983; Lakoff 1987; Tyler and Evans 2001; Bergen and Plauché 2005; among others). The upshot of this work is that there appear to be systematic relations among word senses, many of which plausibly relate to the body, including those exemplified above. As Gibbs and Colston (1995) point out however, without confirmation from other types of evidence, like psycholinguistic experimentation, this work presents only part of the story.

3.6. Metaphor

But likely the most widely recognized and influential place where embodiment has played a role in Cognitive Linguistics is metaphor (Gibbs this volume). It's not hard to believe that the body should matter to how language about perception and action is structured. But it would be more surprising and revealing if we were to find that the body also matters to how language about abstract concepts like morality and transfinite numbers. That is what an embodied theory of metaphor would claim.

If the ability for abstract thought in general is grounded in our experiences in our bodies, then this would have important consequences. For one, in practical terms, it would be impossible to study any human cognitive endeavor without taking into consid-

eration its bodily grounding, whether it be economic or political decision making or logical or mathematical inference. (Indeed, this has been a large part of George Lakoff and his colleagues' research program, applying embodied cognitive science to philosophy [Lakoff and Johnson 1999], math [Lakoff and Núñez 2000], and politics [Lakoff 1996]). Second, in terms of the question of the relation of the mind to the body, it would suggest that the body matters even to the least likely of mental capacities – if any human capacity is immune to embodied influence, then certain it would be abstract thought. And third, in terms of the organization of the mind, embodiment of abstract concepts would suggest massive reuse of and interconnection among the various brain systems we have evolved, and would argue against any sort of strict modularity. At its core, the embodied metaphor story is a story about how we come to think and talk about abstract concepts, basing our understanding on concrete perceptual, motor, and affective experiences.

Certain parts of the literature on metaphor highlight aspects of embodiment. For one, it has frequently been observed that the body and bodily experiences are frequently taken as source domains, sometimes systematically across languages, and sometimes not (Kövecses 2002). Moreover, the preferred explanation for why bodily experiences come to act as sources for abstract targets is that the two systematically co-occur in early experience – perhaps because we co-experience affection and warmth, warmth, which can be concretely felt by the body, comes to relate to and subsequently structure and stand for affection. If this is true, then the body would play an integral role in the formation of metaphor.

But as noted by Grady (1997) there are exceptions. We have metaphors like THEORIES ARE BUILDINGS or SOCIETY IS A FABRIC, in which the source, though assuredly more concrete than the target, is nevertheless not particularly related to early bodily experience, and certainly not systematically co-occurring with the target. Perhaps, Grady has suggested, there are different sorts of metaphor. Some, so-called *primary metaphors*, are embodied in the way suggested above for AFFECTION IS WARMTH. Others, like THEORIES ARE BUILDINGS, are grounded indirectly through the combination of multiple primary metaphors.

How can we tell exactly how embodied metaphorical language and thought is? Work on polysemy, including ways in which the body has been hypothesized to matter through metaphor, metonymy, and so on, has been extremely influential in the growth of prominence of Cognitive Linguistics research. At the same time however, there are limits to what it can reveal about embodiment, perhaps best articulated through an example. The word *see* describes both vision and comprehension, and there are systematicities in which words have which pairs of such meanings. But how and when does the body matter to these patterns? That is, in exactly what way is embodiment intervening? It's possible that in the minds of contemporary adult English users, there is a functional connection between understanding and vision such that when they use the word *see* in the understanding sense, they are also activating knowledge about vision. But distributional linguistic evidence by itself is not compatible uniquely with this possibility. Gibbs et al. (1997) nicely articulate a range of possible degrees of metaphorical embodiment (see also Boroditsky 2000). Perhaps adult language users access vision only when reflecting consciously on polysemy patterns, as linguists do, but not when normally using language. Perhaps embodiment plays a role in the development of adult language and concepts, but fades away once a system is learned. This is the idea that metaphor helps people

learn about abstract concepts by bootstrapping them off of more concrete ones, but that these connections are severed once developing minds have learned that seeing is not in fact understanding. And a more extreme version is also possible – perhaps embodiment only matters as a force in language change; on this account metaphors are cognitively “dead” and embodiment that might have mattered at the time of creation or adoption of novel senses for words is no longer relevant in either developing or adult language users once those changes have been propagated throughout a language community.

And to complicate things even more the same degree of embodiment need not necessarily apply to all users of a language or to all units within a language. So it could be that dead metaphors exist alongside ones that are fully alive, cognitively. And linguistic analysis by itself can’t discriminate which language is embodied in which way for which people.

Aware of this limitation, different sorts of evidence have brought to bear on how active a role embodiment plays in what functions.

- Some evidence comes from novel uses of metaphor or metonymy to produce new uses for words that aren’t already polysemous. For instance, if metaphorical mappings are still active in the minds of language users, then this should manifest in systematic interpretations of extensions of source domain language to target domains. A metaphor like UNDERSTANDING IS SEEING has a large number of lexical items with a foot in each domain, like *see*, *clear*, *cloudy*, and so on. But researchers have pointed out at times that completely novel extensions, while unconventional, are readily interpretable (Lakoff 1993). For instance, the intended meaning of *I’d need a scanning electron microscope to see your point* is probably not lost on many English speakers. Novel extensions like this naturally follow the same structural patterns of existing conventional polysemy patterns (understanding is still seeing, things that are hard to understand are hard to see, and so on). And they are interpreted exactly in these terms. So this might constitute evidence that the bodily systems for visual perception matter to our ability to understand language about comprehension.
- Studies of cognitive development have asked whether embodiment plays a role in the acquisition of concepts. For instance, it could be that learning about understanding involves passing through knowledge about vision. Corpus work shows that, for this case in particular, children begin producing the word *see* in situations that involve both sight and comprehension before they begin to also use the word for cases of comprehension in which sight is not relevant (Johnson 1999). This evidence is consistent with the idea that embodiment operates in the development of concepts and acquisition of language.
- Studies of semantic change have shown that words change meanings over time in directions predicted by synchronic metaphor, in the direction from more concrete to more abstract. For instance, words for vision gain additional meanings over time to denote knowledge as well (like the English word *see* has) (Sweetser 1991).

Again, however, although analysis of language patterns is revealing, it is ultimately unable to ascertain whether embodiment has an online function in language use. And because this is a particularly appealing version of embodiment, this has been one major direction of recent theory and investigation, one that has required more contact with experimental psychology and psycholinguistics.

4. Process

Lakoff and Johnson's proposal for online embodiment is that "the same neural system engaged in *perception* (or in bodily movement) plays a central role in *conception*" (1999: 38). Clearly this has been an influential idea. But stated in these broad terms, it's hard to derive specific claims about what mechanisms of the brain and mind are used to what end during the performance of exactly what cognitive tasks, and exactly with what timecourse. To become useful in explaining how people use language, this idea needs to be fleshed out in a theory of exactly how, when, and why which systems would be used during what linguistic and other cognitive functions. In the late 1990s, several research groups converged on a shared idea about how language use might be embodied, online, using systems that perform primary functions for perception, action, or affect. The idea was a simple one: perhaps the language user constructs denotational meaning in his or her mind by activating perceptual, motor, and affective systems to create or recreate the experience of the described scene. This is the *embodied simulation hypothesis* (Bergen 2012; see also Speed et al. this volume).

The embodied simulation hypothesis has been fleshed out in different ways (Barsalou 1999; Narayanan 1997; Glenberg and Kaschak 2002; Zwaan 2004; Feldman and Narayanan 2004; Gallese and Lakoff 2005; Feldman 2006; Bergen and Chang 2005, 2013; Bergen 2012). Some models are implemented computationally, making claims about exactly what processes lead what embodied mechanisms to be brought online at what time (like Embodied Construction Grammar [Bergen and Chang 2005, 2013; Feldman 2006]). Others describe hypothesized mechanisms in verbal terms, but in terms detailed enough to draw out predictions about timecourse of use of mechanisms and degree of detail (Kaschak and Glenberg 2000; Zwaan 2004; Barsalou et al. 2008)

Because these models make nuanced claims about cognitive processes, the appropriate tools for testing them are more properly drawn from the experimental methods of cognitive psychology and psycholinguistics, tools that afford measurements of cognitive operations over time in the online production or processing of language. Much of the work starting in the early 2000s asked people to perform both a linguistic task and a perceptual or motor task, in some order. The premise was that if perceiving some stimulus or performing some action used brain systems that were also recruited by language about similar percepts or actions, then the two tasks should interact. Typically, these studies measure reactions times. For instance, Glenberg and Kaschak (2002) had people read sentences describing motion towards or away from the body (like *You are closing/opening the drawer*) and to then press a button to indicate whether they made sense or not, which was placed either close to or farther away from the experiment participants' own bodies. They found that people were faster to initiate their movement when the direction they had to move their hand in was the same as the direction of motion implied by the sentence. In another study focusing on vision, Zwaan et al. (2002) had people read sentences about objects that implied them to have a particular shape, like an egg in a pan versus a fridge. The participants then saw an image that depicted the object in the same implied shape or a different one, and had to judge whether it had been mentioned in the previous sentence or not. Though the answer to these critical sentences was always 'yes', reactions times differed – again, people were faster when the shape implied by the sentence and depicted by the image matched.

Another early line of work exploited brain imaging, mostly functional Magnetic Resonance Imaging (fMRI). The basic idea was that if understanding language about actions or perceivable events uses brain systems for action or perception in an online fashion, then known motor or perceptual regions should become differentially active when people were processing relevant language. A number of studies found precisely this. For instance, Tettamanti et al. (2005) presented people with sentences about hand, foot, or mouth actions while they laid in an fMRI scanner. They found that parts of the motor strip – the part of the brain that sends electrical signals to skeletal muscles – lit up in a body-part-specific way. The part of the motor strip that controls leg actions was more active when people were processing leg action sentences, and so on.

And these findings extend, albeit in a somewhat more complicated way, to language not about perceivable eventualities and performable actions, but also to language about abstract concepts that are only metaphorically related to perception and action. For instance, Glenberg and Kaschak's original work on action-sentence compatibility effects showed the same strength of effect when people were processing language not only about concrete motion, but also about abstract transfers (for instance, *You dedicated the song to Dan* versus *Dan dedicated the song to you* [Glenberg and Kaschak 2002]). What's more, Wilson and Gibbs (2007) found that performing a source-domain action primes comprehension of metaphorical language using that source domain. For instance, making a fist leads to faster subsequent comprehension of *grasp a concept*, and swallowing leads to faster comprehension of *swallow an idea*. There is also brain imaging work showing that even when processing metaphorical language, the perceptual and motor systems in comprehenders' brains light up in ways corresponding to language about the source domain. For instance, Boulenger et al. (2009) found that foot-controlling parts of the motor system become active when people are processing metaphorical language using foot actions as a source domain (like *Pablo kicked the habit*), while hand-controlling parts light up during processing of metaphorical language using hand actions as source domain concepts (like *John grasped the concept*).

Consequently, as a first-order issue, there is now a sizeable stable of experimental findings showing that language interacts with perception and action in an online fashion. This is especially true of language about perceptual or motor content, but extends at least in a number of studies to metaphorical language or language about abstract concepts.

However, fleshing out predictions of online embodiment to make concrete experimental predictions has also resulted in a great deal of nuance in the actual findings.

Some experiments find facilitation effects between language on the one hand and perception or action on the other (Zwaan et al. 2002; Glenberg and Kaschak 2002). Others find interference (Richardson et al. 2003; Bergen et al. 2007). And this has spawned a good deal of thought about exactly what factors lead effects to occur in what direction and what this all says about how systems for perception and action are in fact used during language production and processing (Kaschak et al. 2005; Bergen 2007).

Other work has shown that embodiment effects sometimes are and sometimes are not detected. This is especially true with metaphorical language, where for instance, some brain imaging studies have found perceptual or motor areas lighting up during processing of metaphorical language using perception or motor control as source domains (Boulenger et al. 2009) while others have not (Aziz-Zadeh and Damasio 2008). The situation is similar with literal language about perceivable or performance events, where the detectability of an embodiment signature appears to depend on subtle features of the linguistic

signal, including grammatical aspect (Bergen and Wheeler 2010) and person (Sato and Bergen 2013). Moreover, it's known people can process meaning more or less deeply, and it's possible that while deep processing is associated with embodiment effects, superficial processing uses different strategies (as suggested by Barsalou et al. 2008).

It's important to note that not just motor systems of the brain but also bodily effectors might be engaged in real time processes of meaning-making. The most obvious uses are in iconic gesture (Hostetter and Alibali 2008) and signs (Taub 2001; Wilcox this volume). When a gesture or sign iconically models or represents an action or the shape, orientation, or motion of an object, it may be serving as an embodied analogue representation. A topic of current discussion is whether and to what extent these uses of the body play a role in meaning-making, beyond other linguistic signs and gestures.

5. Functional role

There's now little doubt that hearing or reading language about perceptible entities and events can result in measurable activity in the brain systems responsible for perception, and the same goes for language about action and the brain's motor systems. But these findings don't answer a more important question: what exactly is the use of perceptual and motor systems good for? What does it do? This is the question of the functional role of online embodiment. And it remains unanswered.

When we move, as the field has, from viewing language statically and analytically to considering language use as an online process, we're confronted with the question of mechanism. What is the best characterization we can come to of how language users produce or process language in real time? What are the component parts of that system? What exactly do they contribute to the outcome – the behavioral results we can measure and the subjective consequences, for example, experiences of successful comprehension?

There are many proposed possible functions that the online use of perception and actions systems could play in language use. The jury is still out, but some proposals include:

- Lexical access: In language comprehension, figuring out what word was intended might be facilitated by performing embodied simulation of the hypothesized sense, or by simulation of the described content preceding that word. In language production, selecting the right word representation might be mediated by accessing perceptual and motor knowledge about the referent of that word.
- Representational substrate: Denotational meaning might be represented in perceptual/motor terms. That is, what we think of as a message to be formulated in language production or to be decoded in comprehension in fact is a perceptual or motor simulation. To the extent that simulations performed by speaker and hearer are similar, they can be said to have similar representational content.
- Inference: An unquantified but surely important portion of language comprehension is performing inferences to flesh out unstated properties. Some of this inference-drawing may use perceptual or motor simulation – perhaps when you read that *Tristan spent all night at the pub and has a headache this morning*, you fill your preferred causal explanation (drinking alcohol? too loud in the pub?) through a process of

- simulating what the scene would be like, based on but not limited to the explicitly articulated details.
- Contextual specification: Words have varied and underspecified denotational ranges. Perhaps embodiment plays an online role in fleshing out the details in a given context – perhaps a given utterance has fundamentally the same denotational meaning regardless of context of use, but varies in its context-specific interpretation by dint of how comprehenders bring their perceptual/motor systems to bear in any given instance (Mahon and Caramazza 2008). For example, perhaps when presented with *The chicken is sick*, people activate different perceptual and motor knowledge about chickens than they do when presented with *The chicken is delicious*.
 - None. Perhaps what appears in experiments to be signatures of embodiment is in fact nothing more than the product of spreading activation based on associative learning that doesn't actually play a functional role in language use. It's possible that people have come to associate words like *jump* with perceptual and motor experiences that tend to co-occur with producing or perceiving that word. Just as a dinner bell might lead automatically to salivation, so *jump* might lead automatically to motor or perceptual traces of jumping. But this does not mean that the motor or perceptual systems play any functional role in language use. It could well be that comprehension and production proceed perfectly well without these associations.

This, then, is the current state of the house that embodiment built. We know that perceptual, motor, and affective systems are activated in a content-specific way during language use. But we don't know what that activation does, mechanistically, for language users. And this is where the attention of embodiment researchers is beginning to turn.

One promising way to investigate function is through knock-out effects. If some cognitive function, say some aspect of language use, relies in a functional way on a piece of brain circuitry, then when that piece of brain is unavailable, either permanently or temporarily, then the cognitive function should be impaired. That's basically the logic of dissociation studies, where damage to a particular brain region knocks out certain cognitive capacities but not others. Applied to embodiment, this logic goes like this: if certain aspects of language use, like those listed above, are in fact functionally dependent on the use of systems for perception or action, then the loss of these brain systems should make it harder, or even impossible, for people to perform these specific language functions.

There are different ways to knock out a piece of brain tissue in general. The most decisive method is what neuroscientists working with animal models often do – to excise tissue in a careful and localized way. The problem is that only humans have human language and removing brain tissue is not possible with human subjects. So other, less invasive but necessarily coarser means are necessary. One is to take naturally occurring cases of brain damage, and triangulate a particular region that happens to be an overlapping region damaged across patients. The challenges of this neuropsychological approach to dissociations are well known – it's rare to find patients with localized damage to a region of interest, in addition to the fact that the brain's plasticity after trauma means that the patient's brain will have been reorganizing itself since the insult. Another approach is to use transcranial magnetic stimulation (TMS), which induces a transient magnetic field from the outside of the skull that interrupts activity in a narrow, local part of cortex for a brief moment. But there remain concerns about TMS, both in terms of unknown

long-term effects on subjects exposed to it, as well as uncertainty about its underlying physical mechanism. And finally, there are behavioral measures, like adaptation. Neurons can be fatigued by continuous presentation of some stimulus, which leads them to respond less strongly after adaptation than before.

Each of these approaches has seen some use in the function-of-embodiment literature. For instance, Damasio and Tranel (1993) found that patients who suffer damage to the left temporal cortex, where the shapes and other visual properties of objects are represented, often also lose access to nouns. At the same time patients who suffer from lesions to the left frontal cortex, an area dedicated to motor control, tend to have difficulties with verbs. Work using TMS has shown similar results. Shapiro and colleagues (2001) applied TMS to motor areas, and found that this impaired performance on verb production but not on noun production. And finally, there has been some work using behavioral manipulations to fatigue certain brain circuitry. Glenberg et al. (2008) fatigued people's motor systems controlling hand motion in a particular direction, away or towards the body by having them move hundreds of beans in one direction or the other. Then they had them make judgments about sentences describing motion in the same direction or a different direction. They found that when the motor system had been fatigued with action in a particular direction, it took people longer to make judgments about sentences describing motion in the same direction. In sum, a variety of techniques are now being brought to bear on the question of whether embodiment plays a role in online language use, and if so, what role (Speed et al. this volume). But with only a handful of studies pursuing this question so far, the field remains wide open.

6. The future of embodiment in cognitive linguistics

Embodiment as a blanket approach seems to have less substance now than perhaps it had thirty years ago. In part this is because it has been a victim of its own success. The ideas expressed under the banner of embodiment have caught on, so that, in a way only sociologists of science can explain, embodiment has become a hot topic. Everything, it seems, is embodied. Which means that calling research or findings embodied has become less specific and less informative. In addition, the battles that were waged under the banner of embodiment have for the most part been won. It's now inconceivable to most cognitive scientists that language, including syntax, could be informationally encapsulated, or that language wouldn't use other systems, including of the brain and body, or that individual experience wouldn't matter. These are, for the most part, taken as proven hypotheses. So there would appear to be little work left for embodiment as a general concept to do.

But the future of embodiment depends on what we consider it to be. Is it a single answer to a single question? (Is the mind embodied? Yes.) Or is it a class of questions about how the mind might relate to the body? If the latter, then we have barely scratched the surface. And to the extent that we're still asking questions about how language is shaped by the body, we're asking questions about the embodiment of mind. Here are some examples of embodiment-related questions that have persisting potential impact:

- When and how are abstract concepts (including those pertaining to math, time, and so on) embodied? To what extent does embodiment of abstract concepts change through development and depend on the use to which they're being put?

- What are the limits of online perceptual/motor embodiment and what’s happening in those cases that seem to indicate disembodied processing?
- What’s the functional role of these systems?
- What’s the developmental role?

Moving forward, two trends that have already struck elsewhere in the embodiment literature will likely find purchase in Cognitive Linguistics as well (aside from an orientation towards function, as discussed in the last section, which appears to be leading in current embodiment work on language). The first is the situated component of embodiment. It’s not merely the case that we have bodies that might be relevant to the functioning of the mind, but that those bodies are embedded in environments, which they interact with continuously. Situatedness can be relevant to language in a variety of ways. The way we use language is not independent of the situations of use; deixis, reference, gesture, and so on, which are already topics under cognitive linguistic scrutiny, might be well served by a careful look at how the situated nature of linguistic cognition affects the form and processing of language.

The second relevant trend is one that’s somewhat more philosophically radical; the idea that it’s not merely the brain that performs cognitive operations, but that other parts of the body are also, at times, organs of cognition (Clark and Chalmers 1998; Menary 2006). When people use their fingers to count out days of the week, for instance, external parts of their bodies are part of the physical structure that is performing cognitive operations. To the extent that people’s bodies are engaged to perform cognitive functions during the production, comprehension, or learning of language, aren’t parts of the organism other than the brain also the material substrate of the mind? And what’s more, to the extent that parts of the material world, like writing for instance, serve similar functions, can they also constitute part of the substructure of cognition. To the extent that they are, then it’s not merely that language is embodied in the brain; it’s embodied in bodies and the material world around them, which, in concert, enact cognition (Hutchins 1995).

There’s no longer any question that the body matters to the mind. The continuing question of embodiment is exactly how.

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