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Language as a disruptive technology: abstract concepts, embodiment and the flexible mind

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A growing body of evidence suggests that cognition is embodied and grounded. Abstract concepts, though, remain a significant theoretical challenge. A number of researchers have proposed that language makes an important contribution to our capacity to acquire and employ concepts, particularly abstract ones. In this essay, I critically examine this suggestion and ultimately defend a version of it. I argue that a successful account of how language augments cognition should emphasize its symbolic properties and incorporate a view of embodiment that recognizes the flexible, multimodal and task-related nature of action, emotion and perception systems. On this view, language is an ontogenetically disruptive cognitive technology that expands our conceptual reach.

This article is part of the theme issue 'Varieties of abstract concepts: development, use and representation in the brain'.

1. Introduction

What is the role of the language system in embodied cognition? This paper offers a theoretical framework for answering this pressing question. Building on Andy Clark's suggestion that we are natural-born cyborgs [1], it proposes that language can be thought of as a disruptive cognitive technology that transforms the embodied mind. Just as the adoption of new technologies often upends our social, cultural and economic lives, the acquisition of a natural language alters a child's cognitive purview. It disrupts embodied cognition by offering a new medium through which to capture experience [2]. Experience with language leads to the development of a distributed neural system able to manipulate linguistic symbols in a compositional and productive fashion. The neurologically realized language system amounts to a distributed action/perception control system that likely relies on hierarchically organized network hubs. Linguistic forms themselves are grounded because they involve actions, sights and sounds, but they are free to capture content in a manner that is not tied to their grounding [3].

On this view, language is an external symbol system—one that has the computational features associated with amodal symbol systems—that we learn to manipulate in an embodied and grounded way. It is just one of the externally sourced symbol technologies that we may acquire [4]. For example, learning how to perform long division on paper requires a similar grounded manipulation of, and interaction with, physical symbols [5,6]. The specialness of language has to do with the pervasive role that it plays in our cognitive lives and the way in which it complements embodied cognition by enhancing our capacity to encode information about the world that goes beyond our immediate experience. This proposal creates a number of predictions. First and foremost, it predicts that much of our conceptual system is not grounded in language but is instead directly grounded in action, emotion and perception systems. Importantly, such thinking without words has its own compositionality and productivity [7,8]. Second, while language is likely to contribute to all types of concepts, it is more likely to be helpful with abstract ones. Third, as a cognitive tool, the role of language should be flexible, context-sensitive and experience-dependent. Finally, because a natural language is an acquired neuroenhancement, its influence should change over the course of development.

The purpose of this essay is to outline and defend the disruptive technology view. The argument proceeds at two levels: the general and the specific. While much of the essay is aimed at the big picture and endeavours to show that the neuroenhancement view integrates and unifies seemingly disparate threads of current research, the last section examines the way in which it offers a promising explanation of a particular linguistic/conceptual phenomenon—metaphor. Together these elements provide a compelling case for thinking that language augments and extends the cognitive reach of the embodied mind.

2. Embodiment

The idea that our concepts are fundamentally embodied has gained a great deal of currency in the psychological and brain sciences. Many hold that the neural mechanisms typically used to experience the world are also used to think about it. By these lights, cognition involves the selective reuse of action, emotion and perception systems to carry out situated simulations of our experience [9,10]. Because of their distal connection to experience, abstract concepts represent a particular challenge for this approach [11]. In this essay, I explore and defend the notion that language provides an especially important scaffold for embodied concepts in general and abstract ones in particular.

A diverse body of evidence supports the thesis that our concepts are embodied and grounded [9,10,12]. For example, Pecher *et al*. [13] find a modality-switching cost associated with a property verification task. Participants verified verbally expressed facts involving one modality (such as the fact that *leaves rustle*) more rapidly after verifying a fact involving the same modality (such as the fact that *blenders make noise*) than after verifying a fact involving a different modality (such as the fact that *cranberries are tart*). Hearing motion-related verbs interferes with visual motion processing [14] and visual motion processing interferes with the processing of motion-related verbs [15]. Neuroimaging data provide further evidence of conceptual embodiment. Reading odour-related words (e.g. cinnamon, garlic and jasmine) elicits increased activation in the primary olfactory cortex relative to neutral control words [16], and reading action words (e.g. lick, pick and kick) elicits increased activation in the cortical regions associated with performing the relevant movements [17]. The specificity of the modulated activity can be quite fine-grained. Right- and left-handers exhibit increased activation in the premotor areas that are contralateral to their dominant hands on lexical decisions involving manual action verbs [18]. In addition, the degree to which expert hockey players comprehend hockey-action sentences better than controls correlates positively with activity in the left dorsal premotor cortex [19].

3. The trouble with abstract concepts

All concepts involve abstraction. Horizontal generalization from individual exemplars (e.g. specific dogs) to categories (e.g. the category of dog) lies at the very heart of conceptualization. Vertical generalization linking categories together creates conceptual hierarchies (e.g. pugs are a type of dog and dogs are a type of animal). The ubiquity of abstraction suggests that abstract concepts such as DEMOCRACY, FREEDOM, LEPTON, NUMBER and TRUTH may simply represent one end of a spectrum. Researchers often demarcate abstract concepts by one of several measures, including body–object interaction [20], concreteness [21], context-availability [22], emotional valence [23], imageability [24], semantic richness [25] and strength of perceptual experience [26]. Importantly, while these measures correlate to some extent, they are not equivalent [23]. Such divergence suggests that abstract concepts may form a heterogeneous class. Indeed, a cogent argument can be made that researchers have been too cavalier in assuming that abstract concepts are homogeneous [27]. In this paper, I shall not make this assumption. My argument will simply be that language has an important role to play in concepts in general and abstract concepts in particular. This role may ultimately contribute to a pluralistic account of abstract concepts.

When compared with concrete concepts, abstract concepts tend to refer to entities or events that are harder to perceive with our senses or manipulate with our actions [28], to involve more complex relations, introspective features or social interactions [7,9] and to exhibit greater variability across contexts [29]. Evidence suggests that they may be processed in a different manner from other concepts. For instance, abstract words in a semantic categorization task are associated with a particularly widespread pattern of cortical activation that includes temporal, parietal and frontal regions [30]. This distributed pattern could be explained by the reliance of abstract concepts on a network of association areas [31].

All of this raises a difficult question: How can one capture abstract content using grounded mechanisms? Certainly, one of the purported benefits of embodiment [7,32,33] is its ability to overcome the *symbol grounding problem* [34]. This problem arises because a system containing only abstract symbols and their interrelations struggles to explain how individual representations come to be associated with objects and events in the world. Supporters of embodiment propose that this problem is overcome by the experiential connections between the representations of modality-specific sensorimotor systems and our external environment (both physical and social). This benefit may come with a cost, however, because representational systems containing only modality-specific symbols face a corresponding *symbol ungrounding problem* [11]: that is, any theory that posits a central role for experiential mechanisms in our concepts must explain how we are able to acquire and understand concepts that go beyond our experience [35–37].

4. The role of language

Although, much of the initial research implicating sensorimotor and affective systems has focused on concrete concepts, researchers have begun to investigate tasks involving abstract ones. Evidence has come to light that implicates action [38,39] and emotion [23] systems with the processing of these concepts. As things stand, though, there is insufficient reason to think that abstract concepts rely exclusively on affective and motor activations. A number of theories propose that the language system, or at least our experience of language, plays a significant role in our conceptual system. Examples include embodied conceptual combination theory (ECCo) [40], language and situated simulation theory (LASS) [41], symbol interdependency theory [42] and word as social tool theory (WAT) [43]. Because I do not have the space to critically evaluate each of these theories (for reviews, see [28,44]), my strategy instead will be to examine the core generalizations behind them and then offer an overarching theory that integrates these generalizations and exhibits both explanatory and predictive power.

Embodied cognition posits an intimate link between cognition and experience, and a great deal of our experience is with language itself. Some have proposed that this raises the possibility of merging embodied and distributional approaches to word meaning [42,45–47]. Traditionally, these approaches have been viewed as competitors; embodied accounts have focused on situated interactions with the world and distributional accounts have focused on formal relationships between symbols [39]. Distributional models treat concepts in terms of knowledge of statistical patterns derived from spoken and written language. In addition to being particularly effective at capturing abstract concepts, they have enjoyed some success in explaining performance on both lexical access and lexical similarity tasks [48]. However, because they depend on the statistical relationships between abstract symbols, they struggle to overcome the symbol grounding problem [32]. Recognizing that linguistic and non-linguistic experiences can be treated as independent, yet complementary, sources of information about the world, several researchers have proposed that these approaches can be combined [42,45,47]. Indeed, there have been several demonstrations that hybrid embodied/distributional models can outperform similar models that limit themselves to either embodied or distributional information alone [49–51]. Furthermore, several behavioural studies identify independent language-based and embodied factors in conceptual processing [41,42].

Other theorists have explored the idea that linguistic forms themselves might influence embodied conceptualization. In one of the most detailed attempts to model the neurological mechanisms responsible for connecting the language and conceptual systems, Pulvermüller [52,53] proposes that linguistic forms play a constitutive role in the formation of action perception circuits. Learning a language, on this account, leads to the formation of these distributed circuits by means of Hebbian and anti-Hebbian mechanisms. In other words, linguistic forms serve as a means of stabilizing and organizing grounded representations. Lupyan & Bergen [54] similarly argue that language acts as a control system that, in their words, 'programmes the mind' by enabling the active manipulation of sensorimotor representations. This conception builds on previous behavioural data demonstrating that verbal cues (such as the spoken word *dog*) activate more general representations than non-verbal cues (such as the sound of a dog barking) [55,56]. What unites the different instances of this second type of approach is the recognition that an important feedback relationship may exist between linguistic forms and sensorimotor simulations [57].

A third approach emphasizes the role that the social experience of language plays in shaping our concepts. The most prominent version of this approach is the WAT theory [27]. This theory has four main tenets [28]. The first is that language—broadly construed to include pragmatic and discourse-related elements—is likely to play a greater scaffolding role in abstract concepts than in concrete ones. This tenet accords with psycholinguistic evidence on modality of acquisition indicating that the acquisition of abstract words tends to rely more on linguistic input and less on sensorimotor experience than other words [58]. The second tenet is that differences in the modality of acquisition should lead to differences in how concepts are neurobiologically realized. In particular, WAT theory predicts that abstract concepts should exhibit a greater tendency to engage language areas [59,60]. The third tenet is that these neuroanatomical differences should lead to differences in embodiment: namely, the sensorimotor systems associated with speech production and perception should be more engaged by abstract concepts [61]. Finally, because of their greater reliance on linguistic input, abstract concepts should exhibit greater cross-linguistic variability than concrete ones.

In sum, there are at least three distinct general conceptions in the literature of how language may augment our embodied cognitive abilities and help with abstract concepts. The first focuses on our language-based experience as an additional source of information about our physical and social worlds. On this conception, implicit knowledge of distributional patterns may scaffold certain cognitive activities. The second focuses on the way in which linguistic forms can facilitate and organize the neural implementation of our concepts. On this conception, language transforms the very neural mechanisms responsible for cognition. The third focuses on the social dimension of language acquisition. On this conception, language leverages our intersubjective experience to expand our cognitive horizons. Below I offer an account of how language augments cognition that combines and integrates these conceptions.

5. A theoretical dilemma

The task before us is to provide a theoretical framework for understanding the contribution of the language system to our concepts. I suggest that previous accounts face something of a theoretical dilemma: they tend to be guilty of either sins of omission or sins of commission with respect to the fundamental properties of the language system. The relevant sins of omission generally involve a failure to provide a rich enough account of what makes language special. Too often embodied theories make little mention of the structural properties of the language system and their connection to its ability to capture semantic content. Sins of commission are often associated with fuller accounts of the language system, because they tend to involve, either explicitly or implicitly, amodal representations that capture these all important structural properties. Such amodal representations seem incompatible with the basic tenets of embodied cognition [62].

I am going to adopt a twofold strategy in response to this dilemma. The first part involves outlining an expanded notion of embodiment that emphasizes the flexible character of the distributed representations employed in conceptual tasks. This expanded notion requires an embrace of what has become known as weak embodiment [63]. In strongly embodied theories, sensorimotor systems are directly implicated in conceptual processing [64,65]. Completely disembodied theories, on the other hand, locate concepts in amodal systems and view sensorimotor activations as epiphenomenal consequences of conceptual processing [37,66]. Weakly embodied theories retain a commitment to the proposition that conceptual representations are constituted at least in part by activity in sensorimotor systems while granting that dynamically coordinated activity across multiple distributed regions is central to cognition. Such theories often include activity in cross-modal areas such as convergence zones [67] or network hubs [68,69]. This perspective should not be seen as completely novel or radical. Indeed, several recent reviews [11,63,70] suggest that weak embodiment has become the favoured view among supporters of embodied and grounded cognition. The second part of my strategy involves developing a theoretical account of the way in which our experience with language augments our concepts. The key idea will be that language not only provides access to new sources of information about the world, but also transforms us as thinkers.

6. The flexible mind

One of the challenges facing embodied cognition is that embodiment means different things to different people. Broadly speaking, embodied approaches can be divided into one of two major categories: those that emphasize the influence of the body on the mind and those that emphasize the importance of body–world couplings. What we need is a framework for understanding embodied cognition that integrates ideas about embodiment that focus on body–mind connections with ideas about embodiment that focus on body–world connections. I offer two core conjectures: (i) that adaptive neural reuse is a central feature of the brain mechanisms responsible for cognition and (ii) that manipulation of external resources often serves to scaffold our cognitive endeavours. Rather than focusing exclusively on the contribution of sensory and motor areas, my approach focuses also on the context-sensitivity assumed by many embodied accounts of concepts [71,72]. It fits well with the growing evidence that conceptual representations may vary with stimulus [73,74], task [75–77] and context [78,79].

This framework identifies a number of characteristic features of the mechanisms responsible for our concepts. First, they are fundamentally multimodal. Not only is the interplay between modalities essential to how we perceive and act on the world, it is also important to how we conceptualize its contents. Second, this interplay often depends on mechanisms associated with the ongoing evaluation of incoming sensory input relative to the predictions generated by the motor system [80]. Hard-won experiential knowledge plays an important dynamical role in embodied simulations. Third, the selective nature of embodied simulations requires a hierarchical neuroanatomical organization, both internal to, and across, specific modalities [70,81]. Finally, this approach also holds that the degree and form of embodiment is likely to change over the course of development [82,83].

There will be some that argue that these features have been part of their conception of embodiment all along. After all, Barsalou [7] cites the ability to explain flexibility as a major benefit of his approach. Moreover, Connell & Lynott [84] contend that the dynamic influences that the body, the environment, the relevant goals and the task have on our conceptual representations imply that 'you can't represent the same concept twice'. Wilson & Golonka [71] propose that task-dependence is a central component of embodied cognition. My intention is not to claim exclusive priority but merely to codify what I see as the best approach.

There will be others, though, who claim that the view outlined in this essay amounts to a disavowal of embodied cognition [62]. While I disagree with this assessment, not much hangs on this. The central role played by situated sensorimotor simulations in this account seems sufficient to warrant characterizing it as form of embodied cognition. Moreover, there is precedence for this ascription. Anderson [85], for instance, articulates a radically interactive view of neural reuse while explicitly remaining committed to embodiment. Nevertheless, one may think that the dependence of this approach on intermediate representations undermines the theoretical bite of embodiment [86]. My response to this worry is similar to the one offered above: what ultimately matters is getting the theory right. If the conjunction of the flexible mind hypothesis and the appeal to the language system amounts to an abandonment of authentic embodied cognition, then so be it.

7. Language as a disruptive technology

Zwaan & Madden [87] famously use a pair of analogies to highlight the difference between traditional computational views of cognition [88,89] and embodied ones. They liken the computational mind to a bricklayer that assembles structures out of well-defined mental units and the embodied mind to a beachcomber that builds structures out of whatever has washed up on shore. While beachcombers may shape and modify what they find, much of the original character remains. Situated sensorimotor simulations are similarly likely to preserve aspects of their experiential origins. Without making too much of the analogy itself (after all even driftwood is a structure composed of smaller parts), it is worth pointing out that one of the things that washes ashore is a collection of bricks (i.e. language). A supporter of embodied cognition thus faces a choice: either maintain that the language system is completely separate from our conceptual system or provide some explanation of how the two are integrated. Although the first of these seems contrary to the interactive spirit of embodied cognition, it has been the standard approach—words, phrases and sentences have been treated as mere elicitors of simulations. As we have seen, though, there has been some recent movement towards adopting the second option.

What I propose is that language is a disruptive technology that transforms the embodied mind. This idea is intended to fit with, and build upon, earlier proposals. Vygotsky [90] proposes that internalized language can serve as scaffold for learning. On his view, inner speech can help the child organize, plan and remember actions [91]. Clark [92] emphasizes the degree to which language is a physical transformation of our 'cognitive niche' that extends the abilities of the embodied mind. The act of labelling, for instance, may help learners become attuned to perceptual commonalities and overcome the inherent complexity and noisiness of perceptual inputs [93,94]. More broadly, language creates a novel set of perceptual objects and targets for action. This enables us to model the world by means of the manipulation of an external and shared symbol system.

The suggestion on the table is that language augments embodied cognition. Part of the impetus for this proposal is that the symbolic character of language—the fact that it is an externally derived symbol system that is both compositional and productive—offers a number of potential cognitive benefits. One of these is the common absence of a direct connection between linguistic representations and their referents. This semantic arbitrariness may help them anchor embodied and grounded knowledge. Giving voice to this idea, Zwaan [84] hypothesizes that distributed linguistic representations serve as symbolic placeholders for multimodal simulations.

An additional cognitive benefit may arise from the fact that linguistic symbols are syntactically re-combinable in a way that is independent of the combinatorial properties of non-linguistic embodied and grounded cognition. This independent structural flexibility may make it easier to generate new thoughts and encode unexpected connections between thoughts [95,96]. Developing this idea further, Lynott & Connell [97] propose that conceptual combination arises from the interaction between the linguistic and simulation systems.

Some researchers who acknowledge that linguistic representations have a role to play in conceptual tasks suggest that this role is typically more superficial and less effective than that of other multimodal simulations [41,84,98]. In particular, linguistic symbols are seen as a quick and dirty heuristic that can be used when conditions do not require complex task performance. Of course, the notion of effectiveness is itself notoriously context-sensitive. Indeed, there are at least three problems with the dismissive assessment offered by these theorists: First, as symbolic placeholders, linguistic representations may be particularly effective at resolving the problem of generalization. Recall the studies by Lupyan and co-workers [54–57] demonstrating that verbal cues are more effective at eliciting general representations than modality-specific cues. Second, linguistic representations are associated with external symbols and are thus able to leverage the social character of language. Philosophers of language emphasize the degree to which the linguistic function of labels depends in part on their ability to track referents by means of socially determined causal links [99,100]. Abstract concepts would seem to be particularly good candidates for this sort of reliance on external support. Third, given the fact that abstract concepts often involve complex situations and relational properties, it is far from clear that linguistic representations are eliminable. Although researchers have found some surprising evidence that embodied and grounded representations are activated with abstract concepts during certain tasks, this does not demonstrate that linguistic representations are uninvolved. Furthermore, reviews of functional brain imaging research implicate language-related areas of the cortex in the processing of abstract words [59,60]. Finally, there is reason to think that linguistic representations may be needed for concepts that directly involve language use (e.g. ASSERT, CAJOLE and PROMISE).

Few would deny that language provides a means to gain information about objects and events in the absence of direct experience, and most recognize that language enables us to leverage the knowledge of others. Much of the impetus for pluralistic embodied approaches that incorporate the language system is the idea that language itself can be a rich source of information about our physical and social environment. What distinguishes the current proposal from others is the explicit claim that the structural properties of language are central to its ability to augment cognition.

8. A case study

Thus far, I have defended the proposal that language augments cognition by outlining its broad theoretical promise and pointing to its success at integrating other current views. This proposal is intended to provide an overarching framework for understanding the role of language in our concepts. Given this, one might wonder whether or not it has any predictive bite. In this section, I hope to demonstrate that it does by examining a particular phenomenon in which language appears to scaffold our cognitive efforts. Metaphor is important for the purposes of this essay not only because it may play a role in the acquisition of some abstract concepts, but also because it serves as a useful test case for the disruptive technology approach.

Metaphor has traditionally been seen as both a source of evidence for embodiment and a potential means of solving the problem abstract concepts. Working from observations concerning language use, cognitive linguists have shown that a great deal of our discourse is organized around experiential metaphors [101,102]. Several have proposed that we rely on embodied conceptual metaphors to understand abstract concepts [103–105]. Typically this is thought to depend on mappings from grounded conceptual domains to abstract ones. Perhaps the most well-attested embodied metaphor involves understanding the passage of time as a motion following a linear path along the back-to-front axis [106,107] or along the left-to-right axis [108–110]. Evidence of other embodied metaphors—such as understanding morality in terms of cleanliness [111], power in terms of verticality [112,113] and similarity in terms of closeness [114,115]—has also been found.

Viewing language as a neuroenhancement predicts that the cognitive scaffolding due to conceptual metaphor will be somewhat circumscribed, because it treats metaphor as just one of the ways in which language can augment cognition. This is supported by developmental psycholinguistic research indicating that abstract concepts are part of the vocabularies of very young children but metaphors are not [36,116,117]. Indeed, children's comprehension of metaphor appears to remain poor until they reach 8–10 years of age [118]. Furthermore, there are also groups of people, such as high functioning individuals with an autism spectrum disorder, that acquire abstract concepts despite experiencing pronounced difficulties with metaphors [119].

According to the proposal under consideration, our use of metaphoric simulations should be context-sensitive and task-specific. Some available neural evidence supports this prediction. A number of studies have found that metaphors and abstract concepts elicit different patterns of activation [120–123]. In an event-related potential (ERP) study [124], participants made upward or downward movements with marbles as they read words that had literal (ascend and descend) or metaphorical (inspire and defeat) vertical associations. Congruency effects were found with both types of words when the associations matched the direction of the movements, but their time signatures were different: the effects emerged at 200–300 ms after word onset with the literal movement words but after 500 ms with the metaphoric movement words. The delay with the metaphors suggests that the relevant sensorimotor simulations are not automatically engaged in the same the way that they are with the literal action words. In keeping with the context-sensitivity and task-specificity found generally in embodied concepts [72], attention appears to influence congruency effects between affective evaluation and vertical space [125]. Boroditsky & Ramscar [107] find that people at an airport who are about to fly out or who have just arrived tend to employ an ego-moving perspective on time (to think of themselves moving through time) when answering questions about moving temporal events 'forward' while those who are just waiting to pick someone up tend to employ a time-moving perspective.

An additional prediction associated with the disruptive technology view—one that is not typically associated with embodied accounts of metaphor—is that some uses of metaphor may not engage sensorimotor simulations but rather depend on linguistic associations. This prediction fits with the hypothesis that some metaphors may undergo a gradual process of conventionalization as they become more familiar [126]. Desai *et al.* [127] examine the brain activation elicited by four types of sentences: literal action sentences (The instructor is grasping the steering wheel very tightly.), non-idiomatic metaphor sentences (The congress is grasping the state of affairs.), idiomatic metaphor sentences (The congress is grasping at straws in the crisis.) and abstract sentences (The congress is causing a big trade deficit again.). They found that higher-level sensorimotor regions associated with the described actions showed increased activation with both the action and the non-idiomatic metaphor sentences but not with the idiomatic metaphor or abstract sentences. This suggests that sensorimotor simulations are not essential for the semantic processing of these idioms and fits with the notion that they are 'frozen' metaphors whose content is stored by means of linguistic associations.

One potential objection to the disruptive technology view is that it seems to require a commitment to linguistic relativism (the idea that the natural language one possesses influences the thoughts one is likely to have). While I do not have the space to fully address this concern, some remarks seem warranted. First, a growing body of evidence supports at least a weak form linguistic relativism [128–130]. Second, given the centrality of non-linguistic embodied simulations to the current account, its commitment to relativism need not be full-throated. Third, even critics of linguistic relativism often grant that language influences thinking-for-speaking [131]. On the current proposal, though, the distinction between thinking and thinking-for-speaking is blurred [2]. In sum, a compelling argument can be made that the approach advocated in this essay strikes the right balance with respect to the influence of language on thought. Moreover, research on embodied metaphors provides support for this generalization. For instance, some behavioural studies implicate language-specific metaphors. Examples can be found in studies examining the time-as-space metaphor. Research indicates that speakers of Spanish tend to conceptualize time from left to right [110,132]. Hypothesizing that this might be due in part to the orientation of their writing system, Ouellet *et al.* [109] examine the responses of speakers of Hebrew (which is read from right to left) and speakers of Spanish to words presented auditorily in a temporal judgement task. Speakers of Spanish responded quicker when responding to words associated with the past with their left hand and words associated with the future with their right hand while speakers of Hebrew exhibited the opposite pattern.

While the approach advocated here predicts that experience with particular natural languages should result in differences in embodied metaphors, it also predicts that embodied metaphors should be somewhat flexible and experience-dependent. This is supported by a recent experiment: after introducing a novel metaphor connecting time and weight (the past is heavy and the present is light), congruency effects were found in the weight judgements of books that appeared new or old [133]. It is also supported by the fact that providing participants with a brief exposure to mirror-reversed orthography can reverse the orientation of the congruency effects on temporal judgements associated with a particular language [134]. Some recent evidence also suggests that language-specific metaphors may build upon preexisting non-linguistic embodied mappings. Whereas speakers of Dutch tend to talk of musical pitch in terms of height (the way that we do in English), speakers of Farsi tend to talk of it in terms of thickness [135]. These different linguistic metaphors appear to influence how Dutch and Farsi speakers reproduce recently heard musical pitches in the presence of irrelevant spatial information involving either height or thickness [136]. A follow-up study finds that prelinguistic infants are sensitive to both the pitch–height and the pitch–thickness mappings [137].

Metaphor is often taken as just another data point in the larger case for embodied cognition. Treating it as the outcome of the interaction between an inherently flexible embodied cognitive system and an internalized language system enables us to go beyond the observation that some metaphors engage action, emotion and perception systems. In particular, it predicts that metaphor should emerge gradually in development; be circumscribed in scope, context-sensitive and task-specific; and involve both sensorimotor simulations of bodily experience and linguistic associations.

9. Conclusion

Abstract concepts represent a significant challenge for embodied cognition. The notion that language might help grounded agents acquire and use concepts in general, and abstract concepts in particular, has recently gained traction. Extant accounts, though, tend to commit one of two errors: they either treat language as just another experiential source of information or offer a conception of the language system that is incompatible with embodiment and grounding. This essay provides an account of how language scaffolds the embodied mind in which the symbolic character of language (underwritten by its combinatorial structural properties) is a feature not a bug. The acquisition of a natural language not only expands our access to information about the world, but also serves a neuroenhancement by providing a new medium of embodied thought.

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