Thinking in Words: Language as an Embodied Medium of Thought

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Abstract

Recently, there has been a great deal of interest in the idea that natural language enhances and extends our cognitive capabilities. Supporters of embodied cognition have been particularly interested in the way in which language may provide a solution to the problem of abstract concepts. Toward this end, some have emphasized the way in which language may act as form of cognitive scaffolding and others have emphasized the potential importance of language-based distributional information. This essay defends a version of the cognitive enhancement thesis that integrates and builds on both of these proposals. I argue that the embodied representations associated with language processing serve as a supplementary medium for conceptual processing. The acquisition of a natural language provides a means of extending our cognitive reach by giving us access to an internalized combinatorial symbol system that augments and supports the context-sensitive embodied representational systems that exist independently of language.

Keywords: Action; Concepts; Embodied cognition; Language; Perceptual symbols; Simulation

1. Introduction

An ever increasing body of evidence suggests that action and perception systems play an important role in cognitive processes (for reviews see Barsalou, 2008; Fischer & Zwaan, 2008; Kemmerer, 2010). Our facility with abstract concepts, however, poses a serious challenge to embodied cognition (Chatterjee, 2010; Dove, 2009; Mahon & Caramazza, 2008; Weiskopf, 2007). A number of researchers speculate that natural language may provide a solution to this problem (Borghi & Cimatti, 2009; Boroditsky & Prinz,
2008; Dove, 2011; Louwerse & Jeuniaux, 2008; Scorolli et al., 2011). Although they offer distinct theories, each is committed to the idea that natural language extends our cognitive capacities in ways that facilitate abstraction. The aim of this paper is to build on these proposals and develop a version of this hypothesis that goes beyond the observation that language, as an external artifact, contains information that is relevant to abstract concepts. I propose that the acquisition of linguistic competence provides individuals with access to an embodied representational system that is independent of, and yet interacts with, other embodied representations. In other words, new symbolic abilities emerge through the sensorimotor activities associated with language, enabling it to function not only as a medium of communication but also as a medium of thought.

2. The problem of abstract concepts

Traditionally, cognitive science has examined our concepts from a computational perspective that views cognition as functionally independent from perception and action (Hurley, 2008). Embodied cognition offers an alternative framework, one that views cognition as fundamentally grounded in sensory and motor systems. Although several different conceptions of embodiment have been proffered (Shapiro, 2011; Wilson, 2002; Wilson & Foglia, 2011), there is general agreement that it requires cognitive processes to be partly constituted or constrained by wider bodily structures and processes (Rowlands, 2010). Glenberg (2010, p. 586) suggests that the fundamental idea is that “all psychological processes are influenced by body morphology, sensory systems, motor systems, and emotions.”

There is a robust research program within embodied cognition that focuses on concepts. Cognitive scientists commonly take concepts to be bodies of knowledge that are stored in long-term memory and used by default in higher cognitive activities (Machery, 2009). Conceptual embodiment is typically cashed out in one of two ways. The first treats sensorimotor simulation as central. Barsalou (1999, 2008), for example, maintains that conceptual knowledge is encoded in perceptual symbols that involve the dynamic and selective re-enactment of sensory and motor experiences. The second focuses on the role of action preparation. Glenberg (1997), for example, identifies concepts with patterns of potential action. Although it is common to view these approaches as being in competition with each other, it is also possible to see them as complementary (Borghi, 2005). One way to bridge the gap between them is to emphasize the degree to which simulations can be predictive and thus important for guiding action (Gallese, 2009). Given the lack of consensus in the literature and the possibility of an eventual unification, I will hereafter assume that embodiment can consist of either simulations or action schemas. This seems justifiable because both involve the selective engagement of experiential systems.

Abstract concepts such as DEMOCRACY, ENTROPY, JUSTICE, NUMBER, and TRUTH are a critical issue for embodied cognition because it is difficult to see how they can be captured by representations grounded in sensorimotor systems. There have been notable attempts to address this problem, including appeals to metaphoric extension...
(Lakoff & Johnson, 1980; Lakoff, 1987), situated simulations (Barsalou, 1999), and the role of emotion (Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011), but questions remain concerning the adequacy of these proposals (Chatterjee, 2010; Dove, 2009; Mahon & Caramazza, 2008; Weiskopf, 2007). The purpose of this essay is not to re-litigate this issue but rather to explore the possibility that embodied representations of linguistic experience provide at least part of a pluralistic solution to the problem of abstract concepts.

3. Thinking in words

A natural language is a structured symbolic system that involves a systematic mapping between a virtually unbounded set of thoughts and a virtually unbounded set of sounds or manual gestures. Given our limited cognitive abilities, it is common to explain linguistic competence in terms of a finite set of stored lexical units or complexes and combinatorial principles (Jackendoff, 2007). Classical non-embodied cognitive science has tended to view the symbolic nature of language as reflective of the computational properties of an underlying amodal representational system (Fodor, 1975). From an embodied perspective, though, there is a little reason to assume such a lingual-formal account of cognition. This raises an intriguing possibility: If the underlying cognitive system is not inherently symbolic, then the acquisition of a natural language may provide a means of extending our cognitive powers by giving us access to a new type of representational format.

The symbolic structure of language offers a number of potential cognitive benefits. One of these is the inherent semantic arbitrariness of words and idioms. There is, for example, no extralinguistic connection between the English word *pug* and pugs or the idiom *kick the can* and dying. Indeed, other languages associate phonetically different words or phrases with the same objects and events. This suggests that the representations of most words (putting aside onomatopoeia and rough phonological associations with semantic complexity) are essentially disembodied with respect to their conceptual content (Dove, 2011). An additional cognitive benefit arises from the fact that linguistic symbols are syntactically re-combinable. This explicit structural flexibility may make it easier to generate new thoughts and encode unexpected connections between thoughts (Camp, 2009). Syntactic properties may also support some inferential reasoning processes. For instance, despite the fact that Chomsky’s famous sentence, “Colorless green ideas sleep furiously,” is difficult to perceptually simulate or act upon, we are able to infer that if this sentence is true then the relevant ideas are colorless and green, and they sleep furiously (Weiskopf, 2010). More generally, Shallice and Cooper (2013) argue that representing the meaning of abstract concepts requires certain computational capacities, such as recursion and argument role filling. They contend that the computational capacities offered by embodied cognition are not sufficiently powerful to explain these capacities and hypothesize that abstract concepts are captured by a separable cognitive system. My proposal is that the language system itself provides a means of extending the computational
capacities of embodied cognition. In other words, the language system can play the role of the separable cognitive system posited by Shallice and Cooper.

The general idea is that, when an individual acquires a natural language, she acquires a symbol system that has different computational properties than the embodied codes that exist independently of language (Clark, 2008). Conceptual content can then be captured in part by the associative or inferential relationships of embodied linguistic representations with other embodied linguistic representations (Borghi & Cimatti, 2009; Dove, 2011). A concept such as PUG will not only be represented on a given occasion by multimodal simulations or action schemas associated with interacting with pugs, but also by multimodal simulations or action schemas associated with talking or listening to talk about pugs—that is, sensorimotor experiences of words, phrases, and sentences. Abstract concepts such as DEMOCRACY will tend to be more dependent on linguistic representations than concrete concepts.

4. Embodied language: A new perspective

On the standard understanding of embodied language, semantic content is distributed across action, emotion, and perception systems (Glenberg, de Vega, & Graesser, 2008). The account developed here builds on this approach by adding the claim that meaning can be encoded in terms of distributed embodied representations associated with chunks of language. One might try to capture this idea in terms of an analogy to “inner speech,” but this would only be partially successful. What is right about the analogy is that it conveys the idea that meaning can be captured in the associative or inferential relationships among experiential representations associated with online language processing. The analogy, though, has several important shortcomings. First, we often think of inner speech as a conscious phenomenon. In keeping with this, extant accounts of language-based thought generally view it as a medium of conscious deliberation (Carruthers, 2002; Dennett, 1996). The current account, however, is committed to unconscious processes. Second, inner speech is often thought of as unimodal, whereas the current account is explicitly multimodal. Third, inner speech is often viewed holistically to some degree (despite the fact that it is not vocalized, it remains complete speech in some sense) while the current account leaves room for schematic or incomplete experiential representations (Barsalou, 1999).

Given the widespread recognition that embodiment requires cross-modal orchestration, many supporters of embodied cognition acknowledge that some amodal, paralimbic, or supramodal representations are needed. A controversy exists concerning the role that such representations may play in embodied cognition. Meteyard, Cuadrado, Bahrami, and Vigliocco (2012) suggest that we can distinguish stronger forms of the embodiment thesis (e.g. Barsalou, 1999; Gallese & Lakoff, 2005; Pulvermüller, 2001) from weaker forms (e.g. Binder & Desai, 2011; Simmons & Barsalou, 2003; Vigliocco, Vinson, Lewis, & Garrett, 2004) in terms of the degree to which they allow these sorts of representations. Below (section 6), I review neuroimaging evidence that implicates amodal or supramodal
language areas in the semantic processing of abstract concepts (see also Binder & Desai, 2011; Lindenberg & Scheef, 2007). This evidence fits well with weakly embodied accounts of language processing but ultimately may not be compatible with strongly embodied ones.

It is important to recognize that weakly embodied accounts do not require returning to the sort of modular conception of the mind that Hurley (2008) calls the classical sandwich. According to this conception, central cognition (the meat) is functionally separate from, and intercedes between, action and perception (the bread). Weakly embodied accounts, in contrast, claim that our concepts are at least partially grounded in action and perception systems. An example would be so-called hub-and-spoke semantic theories that posit an amodal “hub” in the anterior temporal lobe and modality-specific “spokes” in sensorimotor areas (Binder & Desai, 2011; Jefferies & Lambon Ralph, 2006). The central hypothesis of this essay could be construed as the claim that some of our concepts are couched in weakly embodied linguistic representations (i.e., action schemas and perceptual simulations of language). In order to get an idea of what such an account of language processing might look like, consider Pickering and Garrod’s (2013) proposal that speech comprehension involves covert simulations of speech production. On their theory, hearers actively compute action representations during speech perception in order to help them predict what they are about to perceive. Although this integration of action and perception is facilitated by a series of intermediate representations at the levels of phonology, syntax, and logical form, it is clear that grounded simulation plays an ineliminable role in their account.

5. Situating the proposal

The current proposal has clear historical precedents. First, it builds on the claim that language can serve as a form of cognitive scaffolding (Vygotsky, 2012). Some supporters of embodied cognition have suggested that our ability to interact with an external symbol system enables us to acquire new skills and capacities (e.g. Clark, 2008; Mirolli & Parisi, 2011). In keeping with this, evidence suggests that verbal counting helps children acquire an understanding of positive integers (Carey & Sarnecka, 2006; Dehaene, Spelke, Pinel, Stanescu, & Tviskin, 1999). In general, cognitive scaffolding has been used to defend the idea of extended cognition (Clark, 2008; Rowlands, 2003). This essay, however, is concerned with the role played by the language system in stored knowledge.

Second, the current proposal has a clear affinity with dual code theory (Paivio, 1971, 1986). According to this theory, our concepts are encoded in two formats: one that is sensorimotor-based and another that is language-based. Most concepts employ both formats, but abstract concepts tend to depend more on linguistic representations. Recently, there have been a couple of attempts to offer embodied versions of dual code theory. One example is the language and situated simulation (LASS) theory (Barsalou, Santos, Simmons, & Wilson, 2008). According to the LASS theory, language comprehension involves the continuous interaction between the processing of linguistic forms and
situated simulations. The role played by linguistic forms is thought to be more superficial than that played by situated simulations; indeed, only the latter handle deeper conceptual processing. Another example is the word as tool (WAT) theory (Borghi & Cimatti, 2009). According to the WAT theory, linguistic forms are not merely a means of engaging simulations but, instead, robust tools that enable us to leverage our social experience. An important element of this theory is the hypothesis that abstract and concrete concepts differ in their mode of acquisition (Scorolli et al., 2011). Abstract concepts require longer lasting social interaction to be acquired, and this ultimately leads to their greater reliance on linguistic simulations.

Third, the current proposal has an affinity with recent attempts to merge embodied and distributional approaches to word meaning (Andrews, Frank, & Vigliocco, in press; Louwerse, 2010; Louwerse & Jeuniaux, 2008; 2010; Vigliocco et al., 2004; Vigliocco, Meteyard, Andrews, & Kousta, 2009; Riordan & Jones, 2010). Distributional accounts derive the meaning of words from their statistical patterns of use in language. For the most part, these two approaches have been treated as distinct alternatives. This is not surprising because embodied accounts focus on situated interactions with the world and distributional accounts focus on formal relationships between symbols. Recently, though, some researchers have proposed that these approaches can be integrated because linguistic and nonlinguistic experiences can be treated as independent yet complementary sources of information about objects and events.

The account offered here has elements of each of these influences but puts them together in a novel way. For instance, while it is committed to the idea that language can serve as a form of cognitive scaffolding, it also goes beyond typical forms of this thesis by proposing that a new conceptual code emerges through the acquisition of language, one that has many of the properties usually associated with the amodal symbol systems favored by traditional cognitive science. In other words, the sensorimotor abilities needed to produce and comprehend language can serve as a de facto amodal symbol system. This fits pretty well with dual code theory. Indeed, the present account can be taken as a variant of the WAT theory. Importantly, though, it does not require a strictly bifurcated view of semantic representation but, instead, is committed to a multidimensional embodied approach in which language plays a special computational role. Finally, the present account can be seen as an attempt to integrate distributional information within an embodied theory of concepts. However, it goes beyond the claim that language serves as an important external source of semantic information. According to the present account, the neurologically realized language system itself serves as an important computational resource.

6. The importance of linguistic experience

The standard view of embodied language focuses on the ability of the language system to engage sensorimotor activity that is related to semantic content. Ironically, this treats language as a functionally separate input system in a way that harkens back to the
classical sandwich. This separation seems dubious from an embodied perspective in which cognition is integrated with action and perception. From this perspective, it seems likely that aspects of linguistic experience that are relevant for action/perception will be important for semantic processing.

In this section, I briefly survey evidence suggesting that we make use of information concerning the statistical patterns of words and larger chunks of language in our concepts. A number of computational models have been developed that extract statistical regularities from large corpuses, including the Latent Semantic Analysis model (Landauer & Dumais, 1997; Landauer, Foltz, & Laham, 1998), the Hyperspace Analog to Language model (Lund & Burgess, 1996), and the Latent Dirichlet Allocation model (Blei, Ng, & Jordan, 2003). The core idea behind these models is that the aggregate of all the linguistic contexts in which a given word appears constrains semantic-relatedness. Despite the fact that these models typically ignore seemingly important linguistic properties such as word-order and phrase structure, they have been shown to perform remarkably well on a number of cognitive tasks, including semantic priming and association. The success of these models demonstrates the informational richness of external language (Louwerse, 2011).

Working within a statistical learning framework, Andrews, Vigliocco, and Vinson (2009) propose that we encounter both experiential data and language-based distributional data. They note that, although these data often correlate with each other, there are reasons to think that the latter will be more helpful with abstract concepts. Hypothesizing that the most effective semantic representations would involve the statistical combination of both types of data, they found that a model that combined these types correlated with behavioral data associated with several cognitive tasks better than models that used only one type.

The success of this integrated model serves as a proof of concept and provides a reason to think that the ability to take advantage of the distributional information contained within natural language would be a useful enhancement to an experientially based conceptual system. This fits well with the proposal that some of our conceptual knowledge is encoded in the associative relationships among embodied linguistic representations.

7. Abstraction and the language system

The suggestion at hand is that the language system carries out two semantic functions: engaging nonlinguistic sensorimotor simulations or action schemas and underwriting symbolically mediated associations and inferences. This proposal generates two predictions that enjoy empirical support.

The first prediction is that modality-specific representations associated with our experience of objects and events should be functionally relevant to some language comprehension tasks (in keeping with the standard conception of embodied language). Compelling support for this prediction is provided by behavioral and imaging evidence of effector-specific activations in motor areas (for reviews see Kemmerer, 2010; Willems & Casasanto, 2011). Scorolli and Borghi (2007), for instance, asked their participants to judge the
sensibility of simple sentences containing a verb that referred to an action typically performed with the mouth, hands, or the feet. Subjects responded by pressing a pedal or speaking into a microphone. Response times with the microphone were fastest with "mouth-sentences," and response times with the pedal were fastest with "foot-sentences." Hauk, Johnsrude, and Pulvermüller (2004) used fMRI to map motor areas in individual subjects by having them move their feet, fingers, or tongues. They then had subjects read action verbs associated with these body parts (e.g. “kick,” “pick,” or “lick”). Reading the verbs associated with the hands and the feet lead to a similar pattern of activation in the premotor cortex to that elicited in the movement tasks. Similar somatopic specificity has been found in other imaging experiments involving different language comprehension tasks (Tettamanti et al., 2005; Rueschmeyer, van Rooji, Lindemann, Willems, & Bekkering, 2010). Willems, Hagoort, and Casasanto (2010) found evidence of what they refer to as body-specific representation: right- and left-handers exhibited increased activation in the premotor areas that were contralateral to their dominant hands.

The second prediction is that the language system should be more central to tasks requiring abstract concepts than to tasks requiring concrete concepts. Below, I review some of the evidence supporting this prediction. Although this evidence is heterogeneous and incomplete, it does implicate the language system in abstract concepts. At the very least, it suggests that the current proposal is worth pursuing.

One of the early indications of an asymmetry between abstract and concrete concepts emerged in behavioral research on concreteness or imageability effects. Imageability is typically defined in terms of the subjective ease with which a word gives rise to a sensory-motor mental image (Paivio, 1971). Although imageability is distinct from concreteness (which is typically defined as the extent to which an item or event can be experienced by the senses), there is clearly a great deal of overlap in the extension of these two measures. For this reason, researchers have tended to treat them as interchangeable (see section 8 below for a discussion of why this might be a problem). In general, concrete/high-imageable words exhibit a number of processing advantages over abstract/low-imageable words (Paivio, 1986; Wattenmaker & Shoben, 1987). There are two prominent explanations of these effects: dual code theory (Paivio, 1971, 1986) and context availability theory (Schwanenflugel, 1991; Schwanenflugel & Shoben, 1983). According to dual code theory, the effects are explained in terms of the greater availability of perceptually encoded information with high-imageable words. Context availability theory, on the other hand, posits only one representational system and explains the effects in terms of the greater contextual information stored in semantic memory networks with high-imageable words.

As mentioned above, the current account shares with dual code theory a commitment to the claim that verbal representations (in this case, weakly embodied ones) play an important role in our ability to possess and use abstract concepts. It is not, however, committed to either a dichotomous semantic system or a unified explanation of concreteness/imageability effects. The important empirical question for us is whether or not there is good reason to think that the language system is particularly important for abstract/low-imageable concepts.
Recent research indicates that different types of semantic richness facilitate processing in different ways. A series of experiments finds that object-related properties such as the number of features associated with a concept facilitate lexical decision tasks in manner that is distinct from language-related properties such as semantic neighborhood density (Pexman, Hargreaves, Siakaluk, Bodner, & Pope, 2008; Yap, Tan, Pexman, & Hargreaves, 2011; Yap, Pexman, Wellsby, Hargreaves, & Huff, 2012). Recchia and Jones (2012) investigated semantic richness effects in lexical decision and naming tasks and found that number of semantic neighbors (but not number of features) facilitated the processing of abstract concepts while number of features (but not number of semantic neighbors) facilitated the processing of concrete concepts.

Event-related potential (ERP) experiments suggest that there is a neuroanatomical distinction between abstract/low-imageable and concrete/high-imageable concepts. ERP studies have found that two components, increased negativities at around 400 ms (N400) and 700 ms (N700), are associated concreteness (e.g., Nittono, Suehiro, & Hori, 2002; West & Holcomb, 2000). These components have been interpreted within the context of an extended dual coding theory (Holcomb, Kounios, Anderson, & West, 1999), which attempts to combine the dual code and context availability theories. This extended theory views the N400 as the result of increased postlexical semantic processing (context availability) and the N700 as the result of imagery processes (dual code). It fits well with behavioral studies that find separate concreteness and context effects (e.g., Levy-Drori & Henik, 2006). There is some reason, however, to be skeptical of the association of the N400 with increased postlexical processing. Recent studies have found an inconsistent relationship between the N400 and semantic richness (Amsel, 2011; Amsel & Cree, 2013; Kounios, et al., 2009; Rabovsky, Sommer, & Abdel Rahman, 2012). In addition, Barber, Otten, Kousta, and Vigliocco (2013) controlled for both imageability and context availability and found both a processing advantage for abstract words and the usual increased deflection of the N400 and N700 with concrete words. They suggest that these ERP differences might reflect the amount of sensorimotor information that is activated and integrated during semantic processing.

There is evidence of divergent topographic distributions with the semantic processing of abstract and concrete words (e.g. Swaab, Baynes, & Knight, 2002; West & Holcomb, 2000). Adorni and Proverbio (2012) applied LORETA source reconstruction to an ERP experiment involving a lexical decision task and found evidence of increased activation of the left medial frontal gyrus and the left temporal cortex as well as decreased activation of extrastriate visual areas in the processing of abstract words (see Lehmann, Pascal-Marqui, Strik, & Koenig, 2009 for similar findings using different tasks). Huang, Lee, and Federmeier (2010) found distinct concreteness effects in the left and right hemispheres, suggesting that there may be more than one source for the neurophysiological distinction. In the end, the implication of divergent neural sources suggests that concreteness/imageability effects cannot be fully explained by a single system (as they would be by context availability theory alone).

Brain imaging evidence provides further support for a neuroanatomical difference between abstract/low-imageable and concrete/high-imageable concepts. For example,
Sabsevitz, Medler, Seidenberg, and Binder (2005) visually presented three words in the form of a triangle and asked participants to decide which of the two bottom words was most semantically similar to the top word. Abstract nouns elicited greater activation in the left superior temporal and left inferior frontal cortex, while concrete nouns elicited greater activation in a bilateral network of association areas. A number of imaging studies find that abstract words elicit greater activation than concrete words in superior regions of the left temporal lobe (Binder, Westbury, McKiernan, Possing, & Medler, 2005; Giesbrecht, Gamblin, & Swaab, 2004; Mellet, Tzourio, Denis, & Mazoyer, 1998; Noppeney & Price, 2004; Sabsevitz et al., 2005) and inferior regions of the left prefrontal cortex (Binder et al., 2005; Giesbrecht et al., 2004; Goldberg, Perfetti, & Schneider, 2006; Noppeney & Price, 2004; Sabsevitz et al., 2005). Although the extant imaging data are somewhat variable, recent meta-analyses find that these areas are the most likely to show increased activation with abstract concepts (Binder, Desai, Graves, & Conant, 2009; Wang, Conder, Blitzer, & Shinkareva, 2010). In keeping with this, Sakreida et al. (2013) carried out an fMRI experiment involving simple sentences that contained pairs of abstract, concrete, or mixed (abstract-concrete and concrete-abstract) words. When they compared the fully abstract pairs to the fully concrete pairs, they found that former engaged the left middle temporal gyrus while the latter engaged a fronto-parietal network.

There is some indication that these left frontal and temporal areas are functionally relevant to semantic processing in healthy individuals. For instance, Papagno, Fogliata, Catricala, and Miniussi (2009) carried out a repetitive transcranial magnetic stimulation or rTMS study. They found that accuracy on a lexical decision task decreased with abstract concepts when rTMS was applied over the left inferior gyrus and when it was applied over the left superior temporal gyrus. A similar interference effect for concrete concepts was found when rTMS was applied over the right superior temporal gyrus.

Cognitive neuropsychology provides further reason to suppose that abstract/low-imageable and concrete/high-imageable concepts are at least partially supported by distinct neurological systems. A number of case studies report a greater impairment for the processing of abstract words than for the processing of concrete words following left hemisphere damage, including patients who present with aphasia (Goodglass, Hyde, & Blumsten, 1969), deep dyslexia (Coltheart, Patterson, & Marshall, 1980; Franklin, Howard, & Patterson, 1995; Shallice & Warrington, 1975), and deep dysphasia (Katz & Goodlglass, 1990; Martin & Saffran, 1992). More controversially, evidence suggests that some aphasic patients who appear to have a verb-specific impairment are better categorized as having an impairment for low-imageable words (Berndt, Haendiges, Burton, & Mitchum, 2002; Bird, Howard, & Franklin, 2003; Crepaldi et al., 2006; Luzzatti et al., 2002; although for a critical review see Vigliocco, Vinson, Drucks, Barber, & Cappa, 2011). Patients with a contrasting impairment for the processing of concrete/high-imageable words are not as common, but this pattern has been found in patients with herpes simplex encephalitis (Sirigu, Duhamel, & Poncet, 1991; Warrington & Shallice, 1984) and patients with semantic dementia (SD), a neurodegenerative disease that primarily affects the anterior and inferior portions of both temporal lobes (Bonner et al., 2009;
Reilly & Peelle, 2008; Yi, Moore, & Grossman, 2007). Recently, it has been suggested that this pattern may not be a typical feature of SD but, rather, an artifact of selecting patients by their behavioral profile. For instance, Hoffman and Lambon Ralph (2011) examined seven patients with SD and failed to find evidence of an absolute advantage for abstract concepts within this group. A recent study by Loiselle et al. (2012), however, suggests that this deflationary interpretation may be premature. This study examined seven patients who had undergone a selective unilateral anterior temporal resection (four in the right hemisphere and three in the left hemisphere) and compared them to healthy controls and a group of patients with a more general semantic impairment. Their performance demonstrated a reverse concreteness effect relative to these controls. The authors propose that damage to anterior temporal regions may be responsible for the reverse concreteness effects found in SD.

As this brief survey shows, a diverse body of evidence supports the notion that abstract and concrete concepts are at least partially handled by distinct neural systems. More specifically, inferior left frontal and superior/medial left temporal regions appear to play a particularly important role in the processing of abstract concepts. Support for the idea that this reflects the contribution of the language system to the processing of abstract concepts is provided by the fact that these areas have been implicated in various aspects of language processing (for reviews see Bookheimer, 2002; Price, 2009).

Admittedly, this evidence is somewhat preliminary. It does not provide unequivocal support for the embodied, language-dependent approach defended here for a couple of reasons. First, it is broadly compatible with quantitative rather than qualitative explanations. Several researchers have proposed that semantic processing in general involves these regions (Binder & Desai, 2011; Binder et al., 2009; Jefferies & Lambon Ralph, 2006; Whitney, Kirk, O’Sullivan, Lambon Ralph, & Jefferies, 2011). On their accounts, the increased engagement of these regions by abstract/low-imageable concepts would simply reflect increased semantic processing. Whether or not such a single system approach can be squared with all the evidence favoring distinct neural sources for abstract/low-imageable and concrete/high-imageable concepts, however, remains to be seen. Second, this evidence is compatible a hybrid approach that posits an embodied non-linguistic conceptual system and a traditional amodal system (Dove, 2009; Shallice & Cooper, 2013). Fortunately, hybrid and fully embodied approaches generate different predictions: on the former, the relevant representations should be amodal and functionally separate, and, on the latter, they should be partially grounded in perception and action systems (for examples of grounded accounts of language processing, see Gallese & Lakoff, 2005; Glenberg & Gallese, 2012; Pulvermüller, 2010).

8. Abstraction reconsidered

Much of the research outlined above treats concreteness and imageability as roughly interchangeable measures of relative abstractness. Given that they are highly correlated, this is not obviously problematic. However, Vigliocco et al. (2013) note that there is an
important difference between them: Concreteness ratings have a bimodal distribution while imageability ratings have a unimodal distribution. Which of these measures is more perspicuous remains an open question (Richardson, 1975). Vigliocco and colleagues suggest that concreteness is preferable on a priori grounds because it fits better with the categorical ontological distinction between abstract and concrete entities. Others argue that imageability is preferable because it fits better with the overall clinical, developmental, and experimental data (e.g., Bird et al., 2003; Paivio, 2013). It is also possible that the two measures tap into different aspects of our concepts.

The difference between these measures is significant because a recent series of experiments compare abstract and concrete words while controlling for age of acquisition, context availability, familiarity, imageability, and other variables. Kousta et al. (2011) found that abstract words have a reaction time advantage over concrete words under these conditions (reversing the usual concreteness effect). Clearly, this advantage cannot be explained in terms of either the dual code theory or the context availability theory. The authors theorize that faster reaction time might be due to the overall tendency for abstract concepts to have a greater emotional content. This is in keeping with an earlier study by Kousta, Vinson, and Vigliocco (2009), showing that emotional valence, regardless of whether it was negative or positive, facilitated lexical processing. Vigliocco et al. (2013) report two findings that further support this proposal. The first involves a regression analysis of a diverse set of 1,446 English words. The authors found that abstract words have a general tendency to have more affective associations than concrete words. The second involves an fMRI experiment comparing the responses to abstract and concrete nouns in a lexical decision task. The authors found that abstract words tended to engage the rostral anterior cingulate cortex (an area associated with emotion processing) to a greater extent than concrete words.

In general, the proposal that emotion plays an important role in some abstract concepts fits well with the multidimensional account defended in this essay. Admittedly, though, it also raises a question: Does this evidence undermine the purported importance of language? Fortunately, it does not. Although abstract concepts, when taken as a whole, may have more emotional content than concrete concepts, many abstract concepts do not appear to be grounded emotional experience (for example, EVEN NUMBER and PROTON). Shallice and Cooper (2013, p. 3) go as far as to suggest that we may need to re-conceptualize abstraction “as what cannot be learnt from sensory experience alone.”

Ultimately, the above experiments exclude the very sorts of abstract concepts that are likely to be problematic for embodied cognition. Two of the variables that these experiments hold constant are particularly important: imageability and age of acquisition. Let us consider them in order. The experiments involve concepts that are abstract relative to concreteness but not relative to imageability. Given that imageability involves inner states and concreteness does not, such “abstract” concepts are likely to have more affective associations than ones with low imageability. Indeed, Altarriba and Bauer (2004) found that emotion words tended to be rated as abstract but imageable. Holding age of acquisition constant similarly excludes problematic concepts. After all, the theory outlined in this essay predicts that concepts acquired later in development will tend to be more language-dependent than
those that are acquired earlier. Moreover, age of acquisition is a diachronic property, and the issue at hand is the synchronic structure of our conceptual system.

The fact that emotional valence appears to facilitate the lexical processing of some abstract concepts does not conflict with the proposal that language generally plays an important role. Instead, it implies that we should get away from single-factor explanations of the abstract/concrete distinction and consider a multidimensional approach.

9. Conclusion

Explaining our facility with abstract concepts represents a significant problem for embodied cognition. As noted above, a number of its supporters have looked to natural language as a solution to this problem. Some have argued that becoming a speaker of a public language creates a form of extended cognition (Clark, 2008; Rowlands, 2003). Others have argued that language serves as an independent conceptual code (Barsalou et al., 2008; Borghi & Cimatti, 2009; Dove, 2011). Others still have argued that acquired natural language provides access to new sources of information that would not otherwise be available (Andrews et al., in press; Boroditsky & Prinz, 2008; Louwerse, 2011; Vigliocco et al., 2009). The account defended here integrates these claims. Two considerations support this integration: First, models of semantic processing that make use of both experiential and language-based distributional data perform better than models that only rely on one of these data types. Second, a diverse body of behavioral, electrophysiological, imaging, and neuropsychological research suggests that the language system may play an important role in the processing of abstract concepts.

A primary theoretical impetus for embodied cognition has been the perception that the sort of abstract symbols employed in standard computational accounts of cognition offer too much representational flexibility (Harnad, 1990). The turn to embodied and situated representations provides a means of grounding our concepts. However, it may go too far. The challenge posed by abstract concepts suggests that more flexibility might be needed. Part of the appeal of hybrid accounts that posit both embodied and disembodied representations is that the latter seem especially suited to encoding abstract information (Dove, 2009). This essay offers a fully embodied alternative in which the symbolic capacities that emerge through the sensorimotor activity of linguistic communication provide a representational flexibility that is not offered by nonlinguistic experiential representations. The ability to represent our concepts in terms of the associations and inferential relations among symbolic representations helps us encode abstract concepts and extend our cognitive abilities.

References


