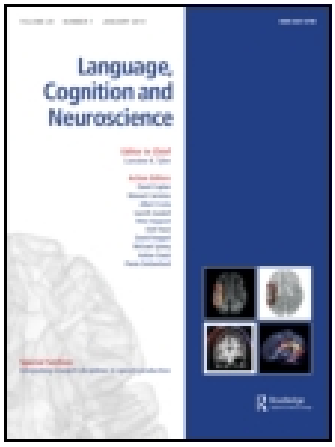


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# What is embodied about cognition?

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# What is embodied about cognition?

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It is currently debated whether the meanings of words and objects are represented, in whole or in part, in a modality-specific format – the embodied cognition hypothesis. I argue that the embodied/disembodied cognition debate is either largely resolved in favour of the view that concepts are represented in an amodal format, or at a point where the embodied and disembodied approaches are no longer coherently distinct theories. This merits reconsideration of what the available evidence can tell us about the structure of the conceptual system. We know that the conceptual system engages, online, with sensory and motor content. This frames a new question: How is it that the human conceptual system is able to disengage from the sensorimotor system? Answering this question would say something about how the human mind is able to detach from the present and extrapolate from finite experience to hypothetical states of how the world *could* be. It is the independence of thought from perception and action that makes human cognition special – and that independence is guaranteed by the representational distinction between concepts and sensorimotor representations.

**Keywords:** embodied cognition; conceptual representation; semantics; spreading activation; representational format



> If I give someone the order 'fetch me a red flower from that meadow', how is he to know what sort of flower to bring, as I have only given him a *word*?
>
> Now the answer one might suggest first is that he went to look for a red flower carrying a red image in his mind, and comparing it with the flowers to see which of them had the color of the image. …But this is not the only way of searching and it isn't the usual way. We go, look about us, walk up to a flower and pick it, without comparing it to anything. To see that the process of obeying the order can be of this kind, consider the order '*imagine* a red patch'. You are not tempted in this case to think that *before* obeying you must have imagined a red patch to serve as a pattern for the red patch which you were ordered to imagine. (Wittgenstein, 1958)

The embodied cognition hypothesis is the idea that cognition is mediated by representations expressed in the vocabulary and format of sensory and motor representations. The core of the embodied cognition hypothesis is the claim that the format of cognitive representations is modality-specific and not abstract or amodal. In the last several years there has been an explosion of interest into exploring embodied explanations of varied phenomena (see Figure 1). The focus of the current discussion is on the embodied cognition hypothesis as it applies to conceptual content of concrete object and action concepts. This application of the hypothesis may serve as a litmus test for the embodied approach more generally: if the theory faces difficulties for concrete concepts, it is unlikely that it would work for cognitive domains that are less systematically tied into sensory and motor processing.

There are now many critical discussions of the pros and cons of the embodied cognition hypothesis, and the goal here is not to survey the field; the goal is to motivate a reconsideration of whether we are asking the right question when we ask whether concepts are embodied. The question that implicitly drives most research and discussion is: Why is the sensorimotor system activated during tasks that do not overtly require sensorimotor processing? For instance: Why is it the case that when a participant reads the word 'kick', the motor representation of the leg is activated (for data see Hauk, Johnsrude, & Pulvermüller, 2004)? Or: Why is it the case that when a participant says 'hammer' to a picture of a hammer, information about how to manipulate the object is automatically activated (for data see Chao & Martin, 2000)? Or: Why is it the case that when looking at a picture of ice cream, regions of the brain that support the ability to taste are activated (Simmons, Martin, & Barsalou, 2005; Simmons et al., 2013)? The embodied cognition framework infers from such phenomena that the format of the corresponding concepts is (in whole or in part) modality-specific. So-called disembodied approaches typically explain sensorimotor activation in terms of spreading activation between conceptual representations (represented in an amodal format) and sensory/motor systems. And it is here that the theoretical discussion has come to be stuck – there is emerging consensus as much and that some redirection is required (Avenanti, Candidi,

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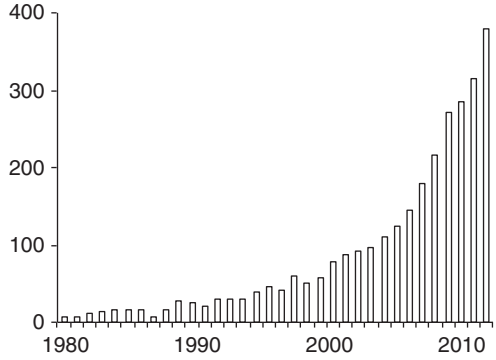


Figure 1. The histogram plots the number of articles with 'embodied' or 'embodied cognition' in the title or keywords, published by year since 1980 (PubMed Search). The figure is a graphical representation of the accelerating interest in embodied cognition.



& Urgesi, 2013; Binder & Desai, 2011; Chatterjee, 2010; Dove, 2009; Hauk & Tschentscher, 2013; Hickok, 2014; Kemmerer, in press; Kiefer & Pulvermüller, 2011; Meteyard, Rodriguez-Cuadrado, Bahrami, & Vigliocco, 2012; Willems & Casasanto, 2011; Willems & Francken, 2012; Wilson, 2002; Zwaan, 2014).

A different class of questions can be formulated in the context of the same empirical observations – these questions take as their starting point the recognition that human thought is capable both of indefinite levels of abstraction and of being immersed in sensory/motor representations of the body and the world. Sensory/motor systems never *stop* representing the world and our bodies in it – but our thoughts often have nothing to do with the states of sensory/motor systems. This implies that the human mind must have something like a clutch: something that allows thinking to proceed unencumbered by our representations of our body and the world. How is the conceptual system able to disengage from the sensorimotor system? What is the mechanism that gates information flow within the conceptual system, or selects concepts for use in thought? Answering these questions would be informative about how the human mind is able to detach from the present and extrapolate from finite experience to hypothetical states of how the world *could* be, and about what gives the human mind its flexibility, productivity and inventiveness; in short, answering those questions would tell us something about what makes human thought so special.

## Embodied cognition: or is it a methodological error?

The thesis of this section is that it is a methodological error to draw inferences about the format of representations without an articulated theory of how information spreads in the system (for extended discussion of this issue, see Hauk & Tschentscher, 2013). Consider the recent argument outlined by Pulvermüller (2013a), in his response to prior critiques of his theory. Pulvermüller reasons:

> If 'modality-independent' semantic areas and action/perception systems exchange the information they process, then the latter must receive *semantic* information from the former, be allowed to process, enrich and ground this information with/in information about actions and perceptions and *send the resultant enhanced semantic information back.* [So far, straight disembodied concepts plus interactivity; but Pulvermüller continues:]. Crucially, as semantic information would, in this view, be processed both in modality-independent symbolic and in action-perception systems, it seems impossible to justify why, in such an architecture, understanding should 'occur' only in the modality-independent semantic system. The interactivity statement *implies* that action/perception systems can provide a genuine locus of semantic processing – not necessarily for all symbols, but at least for some.

There are two readings of these arguments. If the issue concerns 'where understanding occurs', rather than whether concepts are represented in a modality-specific format, then the discussion has devolved into a matter of terminology. 'Understanding occurs' in the classroom, at a desk, on a piece of paper and with a pencil – but that is not the type of account that is sought in a neurocognitive explanation of how the brain represents the meaning of words and objects (for discussion of that level, see Wilson, 2002; Wilson & Golonka, 2013; and discussion at that level, see Heidegger, 1927/1996; Wittgenstein, 1958). The second reading of the excerpt from Pulvermüller (2013a) is as a response to the question: Is the format of concepts modality-specific or amodal? As long as a representational distinction is drawn between concepts (in Pulvermüller's terms, 'modality-independent semantic' representations) and 'action-perception systems' then concepts are not modality-specific in their format – regardless of what type of interactivity obtains between concepts and the input/output systems of the brain. Thus, either the discussion has been refocused onto terminology (CF 'where understanding occurs') or we should conclude that the core claim of the embodied cognition hypothesis is capitulated – concepts are not represented in a modality-specific format.

A useful analogy is between the automatic activation of sensory/motor information during conceptual processing (i.e., the evidence for the embodied cognition hypothesis) and the observation that the phonology of unproduced words is activated (for discussion, see Mahon, in press). For instance, Peterson and Savoy (1998) had participants name pictures that had a dominant (e.g., 'couch') and non-dominant name (e.g., 'sofa'). Because one of the names was dominant, the authors could then explore whether the phonology of the non-dominant name was activated (even when participants would not actually produce that non-dominant response). To accomplish that, on a proportion

of trials, participants were presented with the incidental task of reading a word that could either be phonologically related to the non-dominant name (e.g., 'soda' related to 'sofa') or unrelated (e.g., 'table'). Peterson and Savoy found that participants were faster to read words if they were phonologically related compared to if they were unrelated (i.e., 'soda' < 'table'). A received explanation of those data argues that there is cascading activation from semantic representations to phonology: an activated semantic representation, in this case a representation common to the words 'sofa' and 'couch', automatically spreads activation to all words connected to it (i.e., 'sofa' and 'couch'), and activation then propagates to the phonological level (for data discussion, see e.g., Navarrete & Costa, 2005).

By comparison, consider the well-replicated observation, originally reported by Hauk et al. (2004) that there is somatotopic activation of motor representations when participants read action words (for review see Kemmerer, in press; Pulvermüller, 2013a; for critical evaluation, see Caramazza, Anzellotti, Strnad, & Lingnau, 2014; Postle, McMahon, Ashton, Meredith, & de Zubicaray, 2008). Reading the word 'kick' leads to differential activation of the foot area of motor cortex, while reading the word 'kiss' leads to differential activation of the mouth area of motor cortex. The null or default hypothesis for explaining that motor activation, following the analogy to the automatic activation of the phonology of unproduced words, is that activation automatically cascades from semantic representations to motor representations. Key to this default explanation is the idea that motor activation is subsequent to, and contingent upon, semantic analysis of the input (for evidence, see Papeo et al., (in press); for critical discussion, see Bedny & Caramazza, 2011; Leshinkaya & Caramazza, 2014, in press; see also Hauk & Tschentscher, 2013; Kemmerer & Gonzalez Castillo, 2010).[1] This 'default' explanation does not imply that meaning is embodied. The reason why is because the default explanation need not assume that the format of lexical semantic representations is motoric. But that default explanation *was never rejected* before it was argued that the format of the meaning of a word like 'kick' is motoric (e.g., Pulvermüller, 2013b). That is the methodological error that underwrites the embodied cognition hypothesis.

To return to the analogy of the phonological activation of unproduced words, one might further propose that activation feeds back from phonology to semantics (e.g., Dell, 1986). Would it then be reasonable, as suggested by Pulvermüller (2013a), to conclude that the interactivity between lexical semantics and phonology, '*implies* that [phonological] systems can provide a genuine locus of semantic processing'? Just because there is interactivity between semantics and phonology, one does not assume that phonology is now the seat of understanding, or even that it has *any* role to play in the representation of the meanings of words. In the case of phonology, it is clear that the format concepts is independent of the format of phonological representations, and that concepts are merely *connected* (via words) to phonology. So why is the temptation to draw inferences about representational format so strong when it is not phonology that is activated during conceptual processing, but rather sensory/motor systems that code information about an object or action?

The argument from the available data to the embodied cognition hypothesis is arguably born of a conflation between issues concerning representational format and issues concerning the extension of concepts. The extension of a concrete object or action concept is some thing or some event in the world, the occurrence of which is registered by the state of our sensory/motor systems. The concept 'kick' is about an action, and that action is represented in the motor system. The prejudice of the embodied cognition hypothesis is to assume that the concept 'kick' is *constituted* by the representation of 'kick' in the sensory/motor system. Any (seeming) transparency between the meaning of concepts and their instantiation in the sensory/motor system is independent of whether the format of a concept is amodal or modality-specific. The reason why is because the format of a concept and the format of the representations with which it is connected in the input and output systems are independent empirical questions.

One counter to this line of argument is to point out that there is something like an isomorphism between a concept and the sensory/motor information about that concept's extension; in contrast, the phonology of a word is only arbitrarily related to its meaning (e.g., see Meteyard et al., 2012). This objection misses the force of the analogy to the phonological activation of unproduced words – the utility of that analogy is that it clarifies the burden of proof in how to interpret sensory/motor activation during conceptual processing. The default explanation of sensory/motor activation during conceptual processing appeals to processing dynamics, not representational format; and, as argued above, that default explanation would have to be rejected before inferences about representational format would be warranted. Any (seeming) transparency of mapping across distinct levels of representation does not indicate those different levels are not different in their representational format. For instance, in many languages with transparent orthographies, there is a near perfect mapping between orthographic representations and phonological representations – but orthographic and phonological representations are no less distinct in their representational format because there exists a transparent mapping between them. The same methodological principle applies when considering the representational format of concepts.

Another objection that may be raised is to argue that only the strong or radical formulations of the embodied

cognition hypothesis are troubled by the arguments outlined above. Most researchers favour a 'weak' formulation of the embodied cognition hypothesis, and those weaker versions, it is argued, are not vulnerable to the above arguments. Here I suggest that objection is misguided – 'weak' formulations of the embodied cognition hypothesis are either open to the arguments above, or they are not coherently distinct from so-called disembodied theories of concept representation.

## Strong embodiment or bust

Weak embodiment is the view that concepts are not represented *only* by sensory/motor processes, but are also represented at an abstract or modality-independent level (Binder & Desai, 2011; Hauk & Tschentscher, 2013; Kiefer & Pulvermüller, 2011; Lambon Ralph, 2013; Meteyard et al., 2012; Zwaan, 2014).[2] In contrast to weak embodiment, radical or strong embodiment posits that (all aspects of all) concepts are represented in a modality-specific format. The motivation for the weak embodied theory is that it provides a natural account of the activation evidence – both behavioural and neural – while not being vulnerable to the arguments that have been advanced against radical embodiment.

Here I argue that 'weak' embodiment is not embodiment at all – it is the (old) view that concepts are amodal, adjoined to the (new) hypothesis that *conceptual processing* leads to sensory/motor activation. The point of this argument is not that there is anything 'wrong' or 'problematic' with the weak embodied theory – rather, there is nothing substantively different between so-called 'weak embodied theories' and so-called 'disembodied' theories. It is important to be clear on this issue because it is substantive: if the issue of whether or not concepts are represented in a modality-specific format has been resolved, then there is no longer any debate about embodiment (and no longer any embodiment).

### *Strong embodiment*

The core claim of radical or strong embodiment is that conceptual content is represented entirely in terms of sensorimotor information and computations over sensorimotor content. Stated differently, modality-specific information (plus computations over that content) is necessary and sufficient to support all of conceptual processing. This is the strongest form that the embodied cognition hypothesis could possibly take: there is no abstract, modality-neutral conceptual content, but rather only information represented in modality-specific input and output systems. It is not clear whether this strong form of embodiment has ever really been adopted, although Gallese and Lakoff (2005), Allport (1985) and Glenberg and Gallese (2012) come close. Meteyard et al. (2012) suggest that the proposals of Barsalou (1999; see also Simmons & Barsalou, 2003) and Pulvermüller (2005) read at times like strong embodiment, but those proposals arguably leave 'space' for abstract (i.e., amodal) processes and content. Regardless though of whether anyone has actually proposed strong or radical embodiment, it is the standard against which 'weak' embodiment is measured (Binder & Desai, 2011; Meteyard et al., 2012). One immediate problem with strong embodiment is that it offers no obvious 'space' in the mind where the meanings of abstract words could be stored. The suggestion has been made that through a process of metaphorical mapping abstract content is bootstrapped from concrete conceptual content (e.g., Glenberg & Gallese, 2012; Lakoff & Johnson, 1980; for cogent discussion, see Hauk & Tschentscher, 2013). But those extensions to abstract content are logically secondary to the principal application of the embodied cognition hypothesis to concrete content:[3] If the strong form of the embodied cognition hypothesis faces difficulties explaining the representation of concrete content, then *a fortiori* the theory will fail for abstract conceptual content.

The currently available neuropsychological evidence is decisive: we know that modality-specific content can be disrupted (as shown by impairments to modality-specific processing) while conceptual processing is not measurably affected. To quote Binder and Desai (2011): 'conceptual deficits in patients with sensory-motor impairments, when present, tend to be subtle rather than catastrophic' (Binder & Desai, 2011; quoted in, and see discussion in, Hauk & Tschentscher, 2013). Those types of data rule out strong or radical embodiment. By the same token, it is also important to note that there are a number of observations from patient studies that indicate sensory/motor impairments can affect conceptual processing (e.g., Bonner & Grossman, 2012; Kiefer, Sim, Herrnberger, Grothe, & Hoenig, 2008; Trumpp, Kliese, Hoenig, Haarmeier, & Kiefer, 2013). That means that one cannot go to the other extreme and assume that sensory/motor processes are irrelevant to conceptual processing (for discussion, see Binder & Desai, 2011).

### *Weak embodiment*

In recognition of the issues that attend radical embodiment, various 'hybrid', 'pluralistic' or 'middle-ground' approaches have been suggested, termed 'weak embodiment', 'secondary embodiment' or 'neural cell assemblies' (Barsalou, 1999; Hauk & Tschentscher, 2013; Meteyard et al., 2012; Pulvermüller, 2005). For instance, it is in this spirit that Pulvermüller (2013a) defends the view that amodal concepts are representationally distinct from sensory/motor representations, and that 'neural cell assemblies' dynamically link processing across amodal and modality-specific levels of representation. Another

theory, which is arguably a version of the weak embodied theory (for discussion, see Kemmerer, in press), is the hub and spoke model (Lambon Ralph, 2013; Patterson, Nestor, & Rogers, 2007). According to the hub and spoke model, the anterior temporal lobes serve as hubs to mediate the integration of information across sensory/motor systems.

With respect to 'weakly embodied' theories, we need to ask: What would an alternative theory look like? Broadly construed, there are two possible alternatives to 'weak embodiment'. The first is that sensory/motor processes are functionally irrelevant for conceptual processing. This view can be rejected, outright, on the basis of the same evidence that has been marshalled in support of the embodied cognition hypothesis (both neuroimaging and patient evidence; for discussion, see Binder & Desai, 2011). It is not clear if such a view has been defended, caricatures notwithstanding – so I will set that alternative aside. The second alternative to weak embodiment would argue that, like weak embodiment, concepts are represented at an amodal level, but that the activation dynamics of the system are such that conceptual processing does not involve sensory/motor processing. But if that is the alternative to weak embodiment, then what distinguishes weak embodiment from its putative alternative is not a claim about the format of concept representation, but rather a claim about how information spreads between concepts and sensory/motor systems. The substance of the embodiment debate, which used to be about whether the format of concepts is abstract or modality-specific, has morphed into a discussion about whether activity spreads from amodal representations to sensory/motor representations and back again. Pulvermüller concludes that if interactivity between amodal concepts and modality-specific information is posited, then an embodied account of meaning follows – the mistake in that argument is to conflate processing with representation (e.g., Hauk & Tschentscher, 2013).

To summarise: In the measure to which proponents of the embodied cognition hypothesis support a version of weak embodiment, the *only coherent alternative* is the view that there is no spread of activation between amodal concepts and sensory/motor systems. Thus, weak embodied theories and their alternative are in agreement on the issue on which they purport to disagree: the format of conceptual representation. The 'debate' is now about whether or not there is interactivity between amodal concepts and sensory/motor systems – but no theories deny such interactivity. This means that: (1) the core issue at stake in the discussion about whether concepts are embodied has been resolved: concepts are represented in an amodal format, and (2) there is interactivity between amodal concepts and sensory/motor systems.

## Is grounded cognition embodied?

The embodied cognition hypothesis is often motivated by the efficacy of its solution to a long-standing issue that is supposed to attend theories of amodal concept representation: how are concepts 'grounded' in the sensory/motor systems? In the context of the radical or strong embodied cognition hypothesis, the grounding problem sublimates – there is no grounding problem to be solved, because concepts are already *made up of* sensory/motor information and processes. However, as discussed above, most theorists working within the embodied cognition framework eschew radical or strong embodiment, in favour of one or another form of weak embodiment. The basic commitment of the weak embodied perspective is that an amodal level of conceptual representation is strongly interactive with sensory/motor representations. But then, with respect to grounding, we are back where we started – amodal concepts have to be *grounded* in the sensory/motor systems. How is that done? Schematically, at least, the answer is not so complex: A line is drawn from the concept to the corresponding sensory/motor information. Grounding solved. Pulvermüller (2005) refers to such connections as 'neural cell assemblies'; we referred to this type of an approach as 'grounding by interaction' (Mahon & Caramazza, 2008; see also Binder & Desai, 2011).

The idea of 'grounding by interaction' is perhaps most developed in the Sensory/Motor Model of Martin and colleagues (e.g., Chao, Haxby, & Martin, 1999; Chao & Martin, 2000; Martin, 2007, 2009). The Sensory/Motor Model is principally concerned with the organisation of concepts in the brain, and is not committed to the view that the format of conceptual representation is modality-specific. The Sensory/Motor Model argues that: (1) the format of concepts is abstracted away from the primary sensory/motor systems, (2) some of the *content* of concepts is *about* what is represented in the sensorimotor systems and (3) at a neural level, concepts are stored in regions of the brain that are directly adjacent to the primary sensory/motor areas. Hence, and in contrast to how the theory is widely discussed, the Sensory/Motor Model is not an embodied view of concepts, and not even a weakly embodied view of concepts (the same applies to the original proposal of Warrington & Shallice, 1984).[4] This is best illustrated through a concrete example.

Consider the percept/concept 'RED' and the role that it plays in the concept 'FIRE'. Part of having the concept fire is knowing that fires can be red – but that knowledge, that fires are red, may or may not be assumed to be couched in terms of modality-specific representations of 'red'. According to a (truly) embodied account, when answering the question 'What color is a campfire?' one 'simulates' sensory information pertaining to campfires, and it is in virtue of such simulations that the question is answered (e.g., Zwaan, 2004; for relevant critical

discussion, see Pylyshyn, 2003). Such a simulationist view would be fully embodied in the sense that the information that fires are red is represented via a process of reactivation of the actual sensory systems that perceive colour – hence the information 'red', as it figures in the concept FIRE, would be stored in a sensory format. We know that such a theory, as applied in the domain of colour, cannot be correct because patients can be impaired for perceiving and recognising colours (achromatopsia) but spared for their knowledge of the colour of objects (e.g., Shuren, Brott, Schefft, & Houston, 1996), as well as the reverse (colour agnosia without achromatopsia; Miceli et al., 2001; Stasenko, Garcea, Dombovy, & Mahon, 2014). That double dissociation rules out the view that processes mediating colour perception are the substrate of the knowledge 'fires are red'.

An alternative theory argues that the knowledge that fires are red is not stored *via* the systems that perceive red, but *adjacent* to those systems. The implication is that the representation of the 'redness' of fires is not in a sensory format but in some format that is abstracted away from the currency of the systems that actually perceive red. Simmons, Ramjee, Beauchamp, McRae, and Martin (2007) have articulated such a view, and found that knowledge of object colour is in fact stored *close to* (just anterior to) the brain region that actually perceives colour (for precedent, see Martin, Haxby, Lalonde, Wiggs, & Ungerleider, 1995). Simmons et al. (2007) found neural overlap between colour perception and object colour knowledge – but the overlap was in the anterior region, not the posterior region that was activated only during colour perception [see Martin (2009) and Thompson-Schill (2003) for discussion of the 'anterior shift' hypothesis]. Thus, with respect to the issue of whether knowledge of object colour is 'embodied' or not, the issue is settled: conceptual knowledge about object colour is not stored in the format of the representations involved in actually perceiving colour (see neuropsychological data), but it is stored directly adjacent (anterior) to the neural representation of those processes (see imaging data – Simmons et al., 2007).[5] There is nothing *embodied* about such a theory; the reason why is that conceptual knowledge is not represented in a modality-specific format.

In summary, I would suggest that we do not really have a grounding problem for amodal concepts; or, at least, the grounding problem is no more urgent in the domain of conceptual representation than it is for other cognitive representations. For comparison, consider how the 'grounding problem' between lexical concepts and phonology has been solved: a connection is drawn from a lexical concept, to a lexical representation, and then to phonology. There is no (and should not be any) concern that concepts are deracinated from phonology, or that we need a new theory of conceptual representation in order to understand how concepts can be translated (or 'transduced') into phonological information, and vice-versa. The same considerations apply, with full force, to the issue of how concepts interface with the sensory/motor systems.

## What is embodied: concepts or conceptual processing?

The implication of the arguments above is that there is nothing substantively 'embodied' about so-called 'weak embodied theories' (e.g., Meteyard et al., 2012; Pulvermüller, 2013b) – those theories pair an amodal level of conceptual representation with rich information exchange between concepts and sensory/motor systems. Along with acceptance of the thesis that concepts are represented in an amodal format has come a shift in what is putatively embodied: from concepts to 'conceptual processing'. Discussions of embodiment now refer to the entire complex that includes amodal concepts and sensory/motor processes as being the substrate of 'conceptual processing'.

An embodied theory of conceptual *processing* has a very different self-stated goal than an embodied theory of conceptual *representation*. The issue has shifted from being about the format of concepts, to being about the systems that are involved in conceptual processing. This point is obscured in some discussions, with the result that theories are typed as being or not being 'embodied' according to those theories' claims about what type of conceptual *content* is involved in conceptual processing – rather than the theory's claims about the format of conceptual representation (see e.g., Meteyard et al., 2012).

The source of the ambiguity about *what* is embodied (concepts or 'conceptual processing') arises from an equivocation between conceptual content and conceptual format. If information is represented in a modality-specific format, then it is *ipso facto* also about that modality (i.e., its content is modality-specific). But, if information is about a given modality (e.g., information is *about* the visual properties of objects, or *about* object manipulation), then it may or may not also be assumed to be represented in a modality-specific format (see Caramazza et al., 1990 for discussion on this point). The asymmetry between conceptual content and conceptual format has been overlooked by some typologies of theories in the field, and by some attempts to articulate a 'weak' form of the embodied cognition hypothesis. For instance, Meteyard et al. (2012) write: 'Embodiment focuses on the content of cognitive representations and from that derives organizational principles (p. 790, emphasis original)'. That is correct so long as one is referring to strong/radical embodiment – but if one is referring to 'weakly' embodied theories, which assume an amodal level of conceptual representation, then that level of conceptual representation could be *about* a particular modality, without it being modality-specific in its format. As an example: I may represent the knowledge that fires are red in a format that has nothing to do with

the sensory systems that process redness. Thus, the content of my representation that fires are red is about *visual* information – but that does not make my representation that fires are red at all 'embodied'. The only formulation of the embodied cognition hypothesis that is coherently different from a so-called 'disembodied' account of concept representation is the proposal that concepts are modality-specific in their representational format. Thus, the litmus test of whether or not a theory is embodied concerns the theory's commitment regarding the format of concepts – not its commitment regarding the content of concepts.

One objection to this argument is that it draws too strict of a distinction between concepts and the re-entrant activation of sensory/motor systems that seems to attend conceptual processing. As a concrete example, many neuroimaging studies have shown that naming or passively viewing an image of a hammer is associated with activation of parietal and premotor areas (Chao & Martin, 2000; Mahon et al., 2007; Noppeney et al., 2006). At the same time, patients with left frontoparietal lesions and limb apraxia may be impaired for manipulating hammers correctly according to their function but retain other knowledge about hammers (visual form, name, function). Perhaps, the objection would go, the incorrect supposition is that activation of parietal/frontal areas indexes the retrieval of sensory/motor information – perhaps that activation instead indexes the retrieval of a specific type of *conceptual* knowledge (i.e., conceptual knowledge that is about object manipulation).[6] And similarly, the objection would maintain, what we are seeing in some apraxic patients is not a sensory/motor impairment, but rather a conceptual impairment that has affected only one type of conceptual knowledge (manipulation) while sparing other types of conceptual knowledge (e.g., function). That objection is presented as a means to underwrite a new version of the embodied cognition hypothesis – one that is not vulnerable to falsification by the available patient evidence. But, the objection is not coherent as a reformulation of the embodied cognition hypothesis: the alternative construal of the evidence further *weakens* the embodied cognition hypothesis, rather than re-establishing the theory. If the activation of frontoparietal regions indexes the retrieval of manipulation knowledge that is not in a modality-specific format, then those imaging data are no longer evidence for the embodied cognition hypothesis in the first place. There is nothing 'embodied' about a theory that assumes a sub-type of conceptual knowledge about tools is *about* object manipulation – there is nothing embodied about such a theory because the embodied hypothesis is a claim about representational format, not representational content (for early discussion, see Caramazza et al., 1990; for recent discussion, see Caramazza et al., 2014; Martin, 2009).

## What is the clutch of the human mind?

I have argued that questions about the format of conceptual representations are at best premature, and at worst, theoretically underdetermined: premature because we need a theory of how activation spreads before inferences about representational format can be drawn with any confidence, and underdetermined because once a theory of dynamics is adopted, both embodied and disembodied theories *predict* sensorimotor activation during conceptual processing. Thus, the embodied cognition hypothesis of conceptual representation is either a claim about the format of concepts or it is not coherently distinct from alternatives. From the fact that format-specific knowledge can be damaged while conceptual processing is spared, we can conclude that the embodied cognition hypothesis is either demonstrably false (CF strong embodiment) or not coherently different from alternatives (CF weak embodiment). If this argument is accepted, then the embodied/disembodied debate becomes about a distinction without a difference. On one side of the 'debate' are theories of 'weak embodied cognition' that argue that concepts are not reducible to sensorimotor content, but that thinking involves sensorimotor activation. On the other side are theories of so-called 'disembodied cognition' that argue that concepts are not reducible to sensorimotor content, and that thinking engenders sensorimotor activation. Thus, across all theories that are not demonstrably false, there is agreement that: (1) the representational format of thought is amodal, (2) thinking engenders sensory/motor activity, (3) the context in which thought happens modulates sensory/motor activity and (4) that our thinking is affected by the state of our sensory/motor systems. Where can we go from here?

The many demonstrations of sensorimotor activation during conceptual processing indicate that a default posture of the conceptual system is to be engaged with (relevant) sensorimotor content. By analogy, the default posture of the speech production system is to be 'engaged' with phonology. When we activate a lexical concept or a word, the phonology for that word is automatically retrieved – this makes a certain amount of sense because we do not consider which lexical concept to select simply for the consideration's sake, but ultimately to produce a word. The claim that the default posture of our language production system is to engage phonology does not feel like a controversial claim. It should be no less surprising then that the default posture of our conceptual system is to be engaged with the sensorimotor system. The merit of the language production system is weighed in the language produced, and similarly, the merit of our thinking about how to interact with the world is weighed in our actions and by our mind's ability to predict and interpret upcoming sensory events. What does this mean? It does not mean that thinking *is* a sensorimotor process – it

means that sensorimotor processing is a consequence of thinking (Dove, 2009). So the question becomes: What is the mechanism that allows conceptual processing to interface with sensorimotor representations but to not be *of* sensorimotor representations?

Recently, there has been a lot of interest in the idea that the embodiment of concepts is flexible, and modulated by context (e.g. Kiefer & Pulvermüller, 2011; Hauk & Tschentscher, 2013; Willems & Casasanto, 2011). Within such a framework, retrieving a given concept may or may not activate this or that sensory/motor information, according to the context in which that concept is retrieved. For instance, action verbs that are embedded in a negative sentential context may activate the motor system less than action verbs embedded in a positive sentential context (Tettamanti et al., 2008). Thinking about action attributes versus visual attributes can differentially modulate processing for the corresponding concepts in peri-motor and peri-visual areas (e.g. Van dam, van Dijk, Bekkering, & Rueschemeyer, 2012). In the context of such observations, it has been suggested that concepts are not stable entities, but are rather flexibly modulated by context. On such 'flexible accounts', we should conclude that the word 'push' means something different when it is in a negative or positive sentential context. But, if a theory compels that conclusion, should we not ask whether there is not something wrong with the theory? If a theory is forced to infer that meaning is not stable, then how does the theory explain how our thinking and our communication are stable?

The claim that the 'embodiment of concepts is flexible' gets it all backwards: it is not that the sensory/motor substrate of conceptual representation is flexible – it is that contexts are flexible, and thought always occurs in one or another context. 'Context' here should be construed broadly to include not only the immediate physical environment and social setting in which thoughts are happening, but also the goals of the thinker, her current beliefs and her other thoughts. Because conceptual processing (on all theories) interfaces with the sensory/motor system, the sensory/motor manifestations of conceptual processing are as flexible as the contexts in which (stable) concepts are retrieved. It is true – a word can mean different things, and the meanings of a word have different implications, in different contexts – but that does not mean that the representation of a word's meaning is as variable as those contexts. The advantage of this viewpoint is that it naturally handles how meaning *could be* stable across contexts, while letting the sensory/motor *reflection* of meaning depend on the context in which concepts are used.

The fact that there is flexibility in the sensory/motor manifestations of meaning indicates that sensory/motor processing cannot be what constitutes meaning. Conceptual processing is able to draw on sensorimotor content and processing in a flexible and context specific way precisely because conceptual processing is not constituted by that modality-specific information. It is the independence of thought from perception and action that makes human cognition special – and that independence is guaranteed by the representational distinction between concepts and sensorimotor representations.

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## Notes

1. To turn this around: it is not obvious how the correct region of motor cortex could come to be activated by a printed word if the word has not been interpreted (i.e., processed conceptually). Or – is motor activation (i.e., conceptual processing) merely a type of associative response to a stimulus?
2. Weak embodiment could be construed as arguing one of three things, which may vary somewhat by author: (1) *some* concepts are *completely* embodied, for instance, concrete object concepts and action verbs are represented entirely in a modality-specific format, (2) *some* concepts are *partially* embodied, for instance concrete object concepts and action verbs are partly modality-specific and partly amodal or (3) all concepts are partially embodied. The arguments here do not depend on which version of the weakly embodied hypothesis is assumed, but I assume -2- is the version that most have in mind when referring to the 'weak' embodied hypothesis.
3. Much (most?) of human cognition is directed at conceptual content that does not have extension in the physical world. Think about the conceptual processing in which the reader has engaged while reading this essay to this point. Setting aside the words 'kick', 'hammer' and 'ice cream': Can you think of any conceptual processing during your reading of this paper that *could be* embodied? One rejoinder to such points is the observation that we, as long as we are thinking, are in a first person perspective situated in the world and so there are in fact many sensory/motor correlates to even the most abstract of human endeavours. It is true: the rocket scientist may use a paper and pencil and thus engage the sensory/motor system while working through her calculations – but those kinds of sensory/motor processes simply do not offer any purchase for the types of cognitive processes that are occurring.
4. Early formulations of the Sensory/Motor Model (e.g., Martin, Ungerleider, & Haxby, 2000), which presaged much of the discussion about embodied cognition, more clearly endorsed the view that the ability to complete certain types of tasks (e.g., picture naming) involved, necessarily, access to sensory/motor processing. Recent formulations of the Sensory/Motor Model are agnostic about the representational format of conceptual content (see Martin, 2009).
5. This is agnostic about the format of the representations that are involved in visual imagery. In general, the issue of whether concepts are modality-specific in their format is

independent of whether imagery (visual imagery, motor imagery) operates over a medium that is modality-specific in its format. However, there are a number of illustrative parallels between the debate about whether or not visual imagery occurs over modality-specific representations, and current discussions about embodied cognition (for discussion, see Hauk & Tschentscher, 2013).

6. This raises the general question: Which activation patterns actually index the retrieval of information that is in a sensory/motor format? There has not been nearly enough serious consideration given to this issue in the empirical literature, especially considering how central it is for the evidential status of sensory/motor activation with respect to the embodied cognition hypothesis. For discussion, see Caramazza et al., 2014; Hauk and Tschentscher, 2013; Martin, 2009; for elegant demonstrations disentangling the levels of processing of putative sensory/motor activations, see Simmons et al. (2007) in the domain of colour, Simmons et al. (2013) in the domain of taste and Postle et al. (2008) in the domain of action words.



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