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Curb Your Embodiment

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Abstract

To explain how abstract concepts are grounded in sensory-motor experiences, several theories have been proposed. I will discuss two of these proposals, Conceptual Metaphor Theory and Situated Cognition, and argue why they do not fully explain grounding. A central idea in Conceptual Metaphor Theory is that image schemas ground abstract concepts in concrete experiences. Image schemas might themselves be abstractions, however, and therefore do not solve the grounding problem. Moreover, image schemas are too simple to explain the full richness of abstract concepts. Situated cognition might provide such richness. Research in our laboratory, however, has shown that even for concrete concepts, sensory-motor grounding is task dependent. Therefore, it is questionable whether abstract concepts can be significantly grounded in sensory-motor processing.

Keywords: Abstract concepts; Conceptual metaphor; Situated cognition; Grounding cognition; Action simulation

1. Introduction

Abstract concepts continue to provide a challenging puzzle to theories of cognition. To solve the symbol grounding problem (Harnad, 1990), the grounded cognition framework was proposed (Barsalou, 1999; Glenberg, 1997). In this framework, concepts (mental representations) are simulations of sensory-motor experiences which share processing mechanism with perception and action. An important aspect of this view is that, although

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higher level association areas exist, these by themselves do not represent meaning. Rather, the lower level sensory-motor systems provide the content for mental representations while higher level areas act more like convergence zones (Barsalou, Simmons, Barbey, & Wilson-Mendenhall, 2003). Thus, concepts have the same format as perceptual and motoric experiences. This is fundamentally different from symbolic, amodal accounts of cognition which assume that concepts can be sufficiently represented by higher level abstract symbols.

Many findings are consistent with the grounded cognition framework (e.g., Borghi, Glenberg, & Kaschak, 2004; Glenberg & Kaschak, 2002; Klatzky, Pellegrino, McCloskey, & Doherty, 1989; Pecher, Zeelenberg, & Barsalou, 2003; Solomon & Barsalou, 2001; Stanfield & Zwaan, 2001; Taylor, Lev-Ari, & Zwaan, 2008; Van Dantzig, Pecher, Zeelenberg, & Barsalou, 2008; Vermeulen, Corneille, & Niedenthal, 2008; Wu & Barsalou, 2009; Zwaan, Madden, Yaxley, & Aveyard, 2004; Zwaan, Stanfield, & Yaxley, 2002). Most of these studies are limited, however, to cognitive processing for concrete objects and actions such as *apple* or *kick*. A challenge for the framework is to explain abstract concepts such as *truth* or *power* (Chatterjee, 2010; Dove, 2016). How can activations in the sensory-motor systems represent concepts that have no perceptual properties? It is crucial for the grounded cognition framework to solve this problem, because most concepts are abstractions. Most of the frequently used words in language refer to abstract concepts rather than concrete objects (Gentner, 1981). People talk and reason at abstract levels about many topics, such as emotion (Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011), personality traits (Semin & Fiedler, 1988), and actions (Masson, Bub, & Lavelle, 2013). People probably do not spend so much time thinking about the shapes of apples but rather spend time planning their day or thinking about their relationships with other people. Moreover, abstraction is a complex issue and abstract concepts should not be considered as a single kind of concepts. Abstraction is a matter of degree rather than a dichotomous grouping of concepts (Wiemer-Hastings & Xu, 2005), and there are different ways in which concepts can be abstract (Barsalou, 2003). Thus, one of the greatest puzzles in current cognition research is the question if and how abstract concepts are grounded in sensory-motor experiences. In this paper, I will discuss two ideas. The first idea is that abstract concepts are understood through metaphors. The second idea is that situational sensory-motor experiences give grounded meaning to abstract concepts.

2. Conceptual metaphor theory

The theory that has generated most research so far addressing the grounding of abstract concepts is the Conceptual Metaphor Theory (Gibbs, 1994; Lakoff & Johnson, 1980, 1999). This theory is based on the observation that in language, abstract concepts often are linked metaphorically to a concrete domain. More precisely, the concrete domain is used as a metaphor (the vehicle) to talk about the abstract concept (the topic) such as the concrete domain *vertical position* for the abstract concept *power* (as in *Susan has a high* *position in the department*). Hence, the concrete concept of being higher provides a metaphor for the abstract situation of having power. In this view, the mental representation of the concrete vehicle structures the mental representation of the abstract topic and the vehicle is necessary to fully understand the topic. Because the metaphor's vehicle refers to a concrete physical experience, Conceptual Metaphor Theory might explain how abstract concepts are grounded. This idea is supported by evidence that abstract concepts produce activation of the concrete domain (Boot & Pecher, 2010, 2011; Boroditsky & Ramscar, 2002; Meier & Robinson, 2004; Richardson, Spivey, Barsalou, & McRae, 2003; Winter, Marghetis, & Matlock, 2015; but see Bergen, Lindsay, Matlock, & Narayanan, 2007). For example, in our laboratory we found that when participants read words related to powerful or powerless people (*president, slave*), they were better at identifying letters in metaphor-congruent than incongruent spatial locations (Zanolie et al., 2012). For example, the letter q was identified faster at the top than at the bottom of the screen after a powerful term. These results indicated that participants' visual attention went up after reading a powerful term and went down after reading a powerless term. These and similar findings suggest that processing the abstract concept activated the concrete domain. Moreover, because metaphorical language (*high* or *low* to describe *power*) was carefully avoided in these experiments, activation of the concrete domain could not be ascribed to linguistic priming, supporting the idea that these effects are due to conceptual representations.

Despite these supportive findings, however, the idea that Conceptual Metaphor Theory can fully explain how abstract concepts are grounded in sensory-motor processing is problematic for several reasons (Pecher, Boot, & Van Dantzig, 2011). First, to align the concrete and abstract concepts so that a metaphorical mapping can occur, both concepts already need to have a structured representation. In a strong view of conceptual metaphor theory, however, the abstract concept derives all of its structure from the concrete domain. If the abstract concept does not have its own structure, it is impossible to align it with the concrete domain (Murphy, 1996). In a weaker version of conceptual metaphor theory, the abstract concept has its own structure, which is merely influenced by conceptual mapping. In this version, only the part of an abstract concept that is similar to a concrete domain is explained.

Second, metaphors such as *power is up* are simple image schemas and hence provide only very schematic structure. As a result, image schemas provide structure to many concrete and abstract concepts without giving much meaning to any of them. For example, the *up-down* schema can be applied to many concepts (*mountains, trees, power, mood*) that have little else in common. In order to explain the full richness of abstract concepts, much more is needed (Barsalou, 1999; Pecher et al., 2011). Moreover, image schemas can be perceived in different modalities and thus are considered abstractions of embodied experience themselves (Chatterjee, 2010; Gentner, 2003; Hampe, 2005). For example, the *up-down* schema can be experienced visually, when one sees one thing higher than another, or haptically, when one feels if an elevator is going up or down. Because there is hardly any overlap in concrete experiences for these two events, the *up-down* schema must be represented as an abstraction rather than a sensory-motor simulation. Thus, if the image schema is not grounded in sensory-motor processing, it seems unlikely that it provides grounding to abstract concepts.

Third, some findings suggest that even for concrete concepts, spatial mappings may not be grounded in sensory-motor systems, at least not in a way that makes sense in terms of grounded cognition theories. The idea that cognition serves to support interactions in the world is central to grounded cognition (Glenberg, 1997). Consistent with this idea, and often cited as evidence, is the handle alignment effect (Tucker & Ellis, 1998). Tucker and Ellis showed pictures of objects, such as a teacup or frying pan, to participants and asked them to decide whether the object was shown upright or inverted. To indicate their decision, participants pressed a key on the computer keyboard with their right or left hand. Crucially, the objects were shown with a handle on the right or left side of the object. Participants were faster to indicate the object's vertical orientation with the hand that was on the same side as the object handle than with the hand that was on the opposite side. The explanation for this effect is that visual perception of a handled object automatically potentiates a grasping action toward the handle. Since the handle is shown on one side of the object, an action with the hand that is on the same side is activated. If this happens to be the hand that is also used to make the response, the response action is facilitated by the grasping action that was potentiated by the object in the picture. Because the handle is irrelevant for the task and a real action cannot be performed on the picture, the potentiation effect is assumed to be an automatic response of the motor system to the representation of the object (Goslin, Dixon, Fischer, Cangelosi, & Ellis, 2012; Handy, Grafton, Shroff, Ketay, & Gazzaniga, 2003; Iani, Baroni, Pellicano, & Nicoletti, 2011; Makris, Hadar, & Yarrow, 2011; Pellicano, Iani, Borghi, Rubichi, & Nicoletti, 2010). That is, the object concept is sufficient to activate a grasping action as if the object is real and can be grasped. This idea is consistent with the view that action knowledge forms an essential part of object concepts. Other findings, however, suggest alternative explanations for the handle alignment effect. Because the effect supposedly is due to the activation of a grasping action with the aligned hand, there should be no alignment effect if participants respond with two fingers of the same hand (Tucker & Ellis, 1998). Contrary to this prediction, however, Cho and Proctor (2010, 2011) did obtain alignment effects when participants used the index and middle finger of the same hand to respond to handled objects. The alignment effect was also found when participants responded with their feet (Phillips & Ward, 2002). Some of these findings may have been due to specific methodological details (Bub & Masson, 2010). For example, when the object's body is centered in the participant's visual field, the handle protrudes to the left or the right and might influence spatial attention. In our laboratory, however, we found that even if the experiments are set up to prevent such alternative mechanisms, the size of the alignment effect did not depend on the similarity between grasping action and response action (Roest, Pecher, Naeije, & Zeelenberg, 2016). When participants actually grasped a response device, the alignment effect was not larger than when they only touched a button. These findings are more in line with the view that alignment effects are caused by overlap in relative spatial coding of the stimulus and the response. Participants represent both the stimuli and responses as varying on the horizontal axis, and facilitation occurs when these two dimensions correspond. The coding of these dimensions is assumed to be abstract rather than take the form of actual motor actions (Proctor & Miles, 2014). Moreover, the automaticity of the grasping response has been questioned further by findings that the effect depends on instructions to think about picking up the object (Yu, Abrams, & Zacks, 2014) and on the requirement to choose between two response actions (Roest et al., 2016). To conclude, in contrast to earlier suggestions, the spatial alignment effect for object pictures may have nothing to do with an automatic action potentiation induced by object concepts.

If even visual presentations of concrete objects do not automatically activate compatible grasping actions, we may wonder to what extent we should expect sensory-motor activation of image schemas for abstract concepts. As mentioned above, several abstract concepts might be represented by the verticality image schema, such as *valence* or *power* (Meier & Robinson, 2004; Zanolie et al., 2012), or by other spatial image schemas. Findings of spatial alignment effects for concrete objects suggest, however, that these effects are not due to activation of sensory-motor representations. The objects in the left-right alignment experiments were all artifacts that required a grasping action for their use. Thus, one could argue that grasping should have been central to their meaning. Yet these objects had effects on action responses only if the task was set up to focus attention on the left-right dimension. Moreover, the effects seem to be task induced rather than automatic, further questioning whether image schemas can be central to concepts (see also Lebois, Wilson-Mendenhall, & Barsalou, 2015). When people process abstract concepts, it is unlikely that this will occur in a context that focuses attention on a concrete instantiation of the spatial image schema. Rather, image schemas are likely to be abstractions that are removed from modality-specific processing. Hence, although research suggests that image schemas may play an important role for abstract concepts, because they are abstractions themselves, it seems unlikely that image schemas provide grounding in sensory-motor systems.

3. Situated conceptualization

An alternative idea is that abstract concepts elicit simulations of specific situations (Barsalou, 2005; Barsalou & Wiemer Hastings, 2005; Ferretti, McRae, & Hatherell, 2001; McRae, Ferretti, & Amyote, 1997; Wilson-Mendenhall et al., 2011). There are several reasons to assume that situations have an important role for abstract concepts. Although objects such as *apples* have many context-independent properties (*round, tart, can_be_bitten*), abstract concepts such as *power* are much more context dependent and might actually refer to an entire situation (also called *situated conceptualization*, Wilson-Mendenhall et al., 2011). Providing contextual information often facilitates processing of abstract concepts (Murphy & Wisniewski, 1989; Schwanenflugel & Shoben, 1983; Wattenmaker & Shoben, 1987), suggesting that situations are important to understand abstract concepts. One might argue that many situational details are irrelevant for abstract concepts. For example, that a particular experience of a conversation with a friend happened in the park has little relevance to the concept of *friendship*. Still, literature on problem solving and other effortful cognitive tasks shows that even when a task requires processing abstract principles, people often rely on irrelevant surface features of the problem (Brooks, Norman, & Allen, 1991; Forbus, Gentner, & Law, 1994; Goldstone, 1994; Goldstone, Medin, & Gentner, 1991; Goldstone & Sakamoto, 2003; Goldstone & Son, 2005; Haryu, Imai, & Okada, 2011; Landy & Goldstone, 2007; Ross, 1989; Ross & Kennedy, 1990; Ross, Perkins, & Tenpenny, 1990). For example, when participants solved probability problems, their solution was influenced by irrelevant features of earlier problems, such as whether the problem was presented as the assignment of cars to mechanics or as the assignment of athletics teams to teachers. Such irrelevant contexts influenced solutions even when the correct formula was provided (Ross, 1987). On this account, sensory-motor features from previous experiences contribute to the summary representation of an abstract concept. Since situational experiences contain concrete entities that have sensory-motor features (people, visual objects, actions), this account may provide grounding for abstract concepts.

This idea that abstract concepts are grounded via the representations of concrete concepts that constitute situations rests on the assumption that concrete concepts are *necessarily* grounded in sensory-motor representations. Several accounts of grounded cognition indeed imply that sensory-motor systems are necessary for cognitive processes. On these accounts sensory-motor representations constitute concepts, at least partly. However, this necessity has been questioned (Andrews, Vigliocco, & Vinson, 2009; Dove, 2009; Goldinger, Papesh, Barnhart, Hansen, & Hout, 2016; Mahon, 2015; Mahon & Caramazza, 2008; Matheson, White, & McMullen, 2014; Meteyard, Cuadrado, Bahrami, & Vigliocco, 2012). Mahon and Caramazza (2008) argued that many findings can be explained by associations between concepts and sensory-motor systems rather than overlapping representations. Thus, links may exist between concepts and sensory-motor representations, but the concept itself consists of amodal symbols. Hence, understanding a concept such as *apple* does not require activation of sensory-motor representations. This view does not preclude sensory-motor activations, but it considers these activations to be secondary to the primary process of understanding. Many findings that are put forward as evidence for grounded cognition could be explained also by such spreading activation mechanisms. For example, participants make faster movements toward their body after reading the sentence *Open the drawer* than after reading *Close the drawer* (Glenberg & Kaschak, 2002). This finding is consistent with a role of motor simulation in sentence understanding; in order to understand the meaning of the sentence, the reader simulates the movement described in the sentence and this results in a faster response action if the simulation and response action are in the same direction than if they are in different directions. An alternative explanation, however, is that motor activation occurs only after the sentence has already been understood. Thus, mental representation of the sentence meaning might be amodal, and activation spreads from this amodal representation to the motor system. On this alternative account, sensory-motor systems are not necessary for cognition.

More convincing evidence for sensory-motor grounding would be provided by studies that show impaired conceptual processing under conditions where sensory-motor systems are less available (Mahon, 2015), such as in dual-task paradigms where one task involves conceptual processing and another task involves sensory-motor processing (Matheson, White, & McMullen, 2015; Pecher, 2013; Postle, Ashton, McFarland, & de Zubicaray, 2013; Vermeulen et al., 2008; Witt, Kemmerer, Linkenauger, & Culham, 2010). If sensory-motor systems are necessary for cognition, cognition is expected to suffer if those sensory-motor systems are occupied with a secondary task. Studies using a secondary task design have produced mixed findings, which may cast doubt on the necessity of sensory-motor systems for concepts. In support of the simulation view, Vermeulen et al. (2008) found that participants were slower to verify modality-specific properties (*a banana is yellow*) when they had a concurrent perceptual memory load in the same modality compared to a memory load in a different modality. Vermeulen et al. investigated visual and auditory modalities, both in the primary and secondary task. Their result suggested that concepts share representations with visual and auditory perception.

Other studies have looked at the effect of concurrent motor tasks. When participants named pictures of graspable objects, they were slower if the hand that would be used to grasp the object was occupied than if the opposite hand was occupied (Witt et al., 2010). This suggests that the motor system was causally involved in naming graspable objects. Another study showed that this effect was also found for nongraspable objects, however, and was shown to become facilitatory by a small turn in orientation of the objects that brought the graspable part closer to the location of the hand (Matheson et al., 2014). Matheson et al. therefore suggested that the effect of the concurrent motor task is better explained by attentional factors rather than shared representations between the motor task and the naming task. Other studies did not obtain the predicted interference between concurrent motor and cognitive tasks in situations where interference would be expected. A hand-tapping task was not differentially affected when participants processed words related to hands compared to other body parts (Postle et al., 2013). In our laboratory, we investigated the claim that short-term memory for objects uses the motor system to maintain objects in memory, as was suggested by a brain-imaging study (Mecklinger, Gruenewald, Weiskopf, & Doeller, 2004). In several studies, participants performed concurrent motor tasks while they kept objects in memory (Pecher, 2013; Pecher et al., 2013; Quak, Pecher, & Zeelenberg, 2014). The objects were either objects that people keep in their hand while using them (manipulable objects, e.g., *hammer*) or objects that people usually do not keep in their hand (nonmanipulable, e.g., *traffic sign*). In the motor interference task, participants continuously changed the configuration of their hands by forming a fist and then opening their fingers one by one. This movement is expected to interfere with representations of grasping actions, because they involve different movements of the same body parts (see, for example, Smyth & Pendleton, 1989). Because nonmanipulable objects do not have associated motor actions there should be less sharing between the memory task and the motor task for nonmanipulable than for manipulable objects and thus less interference from the motor task on memory for nonmanipulable than for manipulable objects. Contrary to these expectations, however, the results showed no difference between nonmanipulable and manipulable objects in how memory was affected by the motor interference task. Other studies, however, have obtained interactions between motor tasks and short-term memory for object pictures (Guerard, Guerrette, & Rowe, 2015; Lagacé & Guérard, 2015). A study using repetitive transcranial magnetic stimulation (rTMS), a technique by which an area of the cortex can be temporarily disrupted, showed that this affected performance only in tasks in which participants were explicitly asked to make judgments about manual object manipulation. In several other tasks in which judgments were made to object pictures, no effect of rTMS was obtained (Pelgrims, Olivier, & Andres, 2011). To summarize, although many studies have shown links between sensory-motor systems and cognition, not many studies have shown that sensory-motor representations support cognition.

While it is beyond the scope of the present paper to explain why the results of interference studies differ (see Zeelenberg & Pecher, 2016, for a discussion of the role of the motor system for memory), it is important to note that the role of motor representations for object memory might be limited to very specific task conditions. The items in these memory tasks were highly manipulable objects with functions for which the motor actions that people perform on them are central. Thus, if there is any domain in which cognition and sensory-motor systems should share representations, it should be for these concrete, manipulable objects. That the evidence for such shared representations is weak suggests that these shared representations are used only under specific conditions. Moreover, and perhaps more important, it suggests that sensory-motor systems may not play a large role for the representations of situations either. Situations consist of many different kinds of elements, some of which might be concrete, such as a setting, people, objects, actions, etc. (Wilson-Mendenhall et al., 2011). The results from studies on memory for concrete, manipulable objects question to what extent sensory-motor systems are needed to represent such situational entities.

4. Conclusion

In the previous sections, I described two accounts of abstract concepts that might help us explain how abstract concepts can be grounded in sensory-motor systems—conceptual metaphor theory and situated concepts. However, although there is evidence in support of either view, the question is whether there is much support for the sensory-motor grounding of image schemas or situational entities. Research on the role of the motor system for object pictures showed that motor activation does not happen automatically when graspable objects are perceived and that memory for graspable objects is not negatively affected by limited availability of the motor system. These findings suggest that the motor system is not necessary for concepts, even if the concepts are highly concrete objects whose main functions are tightly linked to human manual actions. Abstract concepts rely even less on sensory-motor representations but instead may get additional meaning from linguistic relations (Andrews et al., 2009), emotion (Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011), or social interactions (Borghi & Cimatti, 2009; for an insightful discussion of various proposals, see Borghi et al., 2017). Of course, it seems unlikely that sensory-motor representations play no role in human cognition at all. Many of the behavioral studies cited at the beginning of this paper show that cognition interacts with perception and action in meaningful ways, and results from brain imaging studies show activity in areas associated with sensory-motor processing during cognitive tasks (see e.g., Binder & Desai, 2011). Rather, human cognition seems to be highly flexible and the use of sensory-motor representations for cognitive processes might depend on the context. It seems reasonable to assume that sensory-motor representations are used if they facilitate the cognitive task or if they are made relevant by task instructions or context. Our findings do indicate, however, that motor representations are not activated automatically and thus do not seem to be necessary for concepts. This implies that in order to explain how abstract concepts are grounded in sensory-motor representations, merely showing that abstract concepts have some sort of concrete properties such as image schemas or situational entities is not sufficient. Additionally, one has to show that, in the context of the abstract concept, these concrete properties are grounded in sensory-motor representations. The likelihood that such concrete properties are grounded in the context of abstract concepts, however, seems small.

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Q/A commentaries related to Diane Pecher's paper, presented at the symposium "*Abstract Concepts: Debating Their Structure, Processing and Modeling*" (Amsterdam, November 18, 2016)

F.P. Thank you very much for this exciting talk and thank you very much for giving an introduction into some of the behavioral evidence related to the grounded account. You say that some of your results do not replicate previous reports in which the activation of sensorimotor areas was found. The crucial question is how to interpret these behavioral results in which no activation of sensorimotor areas was found. The fact that the sensorimotor activation was not observed through behavioral experiments does not necessarily imply that there was no sensorimotor activation at all. Maybe the reason for the negative result has to be found in the specific features of the task conditions. For example, in some cases the tasks might be too just simple to allow the behavioral experiment to track down sensorimotor activation.

D.P. Thank you for your question. Indeed, task conditions might influence the results. But for example, at our lab we found also opposite results: In the grasping experiment, we had one condition in which participants had to choose between two responses (which is a more complex decision), and another condition in which there was a simple go/no-go task. The results showed that participants were actually faster in performing the more complex decision in the first condition than in performing the simple go/no-go task.

F.P. But isn't this even worse, if they are slower in the simpler task? Could this be taken as an indication that, for example, they were just not focused?

D.P. Well, but they are not making errors.

F.P. But if the task is easy, you wouldn't expect errors. You could use the subjects' lack of motivation to explain the slower responses in the simple task. What I am saying is that one could find alternative motivations to explain negative results, rather than "demolishing" grounded cognition.

D.P. Well, I am not really trying to demolish it... (laughs). I am only arguing that, in some cases, when people have found positive behavioral results, and used them to argue in favor of the grounded cognition account, alternative explanations may also be provided. We have done several experiments at our lab, with many variations, precisely to observe how task conditions might affect performance. We are actually trying to replicate some of the studies in which positive results were found, and then see what differences between specific task conditions can motivate why someone finds interference effects for graspable objects and so on. In general, I think the divergent findings show that grounding might not be necessary for all cognitive tasks, and I think the challenge is to find out *when* people use grounding, and when they do not. And the fact that one can perform cognitive tasks without grounding shows that it is not necessary.

F.P. Very well taken. I had several discussions with Alfonso Caramazza and we were at that point several times. And I think the point then is: If grounding is not necessary, how would you explain the *positive* results, some of which you also replicated? If there is no necessary grounding, how could that be that this graspability compatibility effect comes up, at all, with the beer mug? Do we agree that the graspability compatibility effect requires grouding?

D.P. No. I think it *might* be explained by grounding, but it might be also explained by some other principle, for example the polarity correspondence idea, which assumes that participants have a spatial code for the stimuli, so they code the stimuli as having a handle on the left or on the right, and they code their responses as being on the left or on the right. This coding might be abstract, as suggested for example by Proctor, and might not involve sensorimotor simulations.

F.P. But you cannot explain *all* the positive results obtained in various studies, with this.

D.P. You are right. And this is still a puzzle, I agree. But there might be several explanations for the various positive results, one of them being the polarity correspondence. Another explanation, for example in the case of experiments using verbs, might be that sensorimotor activation may be found for verbs, because they have an intrinsic stronger motoric component than nouns.

K.M. Thank you for the nice talk. I have a question about abstract concepts and situations. You suggested that situations themselves may not be grounded, and so we are not getting out of the problem. Here is another way of looking at it: Who cares about grounding! I mean, I am not saying we should not care about grounding, but I am saying this is another way of looking at it. In this scenario, we do still care about how people learn and use abstract concepts, right? So, do you think that understanding the role of specific situations might be useful to understand how do people learn abstract concepts?

D.P. Well, about concluding that situations are not grounded, I am still not convinced. But suppose, hypothetically, that situations are not grounded. Then, whether they help or not to learn and understand abstract concepts, this is still a different view, compared to the idea that people learn abstract concepts through linguistic contexts of use. Yes, I believe that situations are important for learning abstract concepts. Empirical studies indeed have shown that people come up with situation-based features, when they describe abstract concepts.

K.M. And, are those two explanations *not* compatible? I mean: people learning through being exposed to situations, and learning through being exposed to people talking about situations, can they be integrated?

D.P. I think this is indeed a timely empirical question.

AUDIENCE I am trying to understand your position here. Since a concept (concrete or abstract) is somehow a social agreement upon what we will call this thing, it could be that in order to understand the word or the concept we don't need the grounding "in the moment," but perhaps during the evolution that led to establishing the consensus, we used this grounding and now it is part of the meaning, although it is not actively used in online processing.

D.P. I think that grounding is very much *context*-dependent and that's why some studies find evidence for grounding and some do now. In development, I do believe that grounding might be very crucial in the early stages. Children probably learn more from sensorimotor experiences than adults. And then, later on some abstraction might take place, that people may use that as a shortcut in online processing. So, grounding is not always needed, anymore. About evolution, I don't know, it sounds a bit speculative.

G.V. Thank you very much, Diane, for your talk. At the beginning you raised the issue of "abstraction" and my question is: Are the processes of abstraction the same processes that underscore the representation of abstract concepts?

D.P. It is a great question. A representation for *chair*, which is a concrete concept, is already an abstraction of several instances of chairs. But that's not the same as the representation of a typical abstract concept, such as *democracy*. There might be different processes: a process of abstraction and a process of representing abstract concepts.

A.L. About the different processes underscoring abstraction, there are purely abstract words like *democracy*, but there are also metaphorical extensions of highly concrete terms, like *power*: think about *electric power*. This extension affords yet another type of operation: from electric power to political power is a different type of abstraction, compared to the abstraction between *chihuahua* and *dog*.

D.P. You are absolutely right. I believe that today we will learn more about these processes, the different types of abstract concepts, as well as different types of abstraction processes.

Abbreviations

D.P. Diane Pecher

F.P. Friedemann Pulvermueller

K.M. Ken McRae

G.V. Gabriella Vigliocco

A.L. Alessandro Lenci