

Commentary

Do resonance mechanisms in language and action depend on intentional processes?

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The quest in unraveling the mysteries of how the mind produces action has taken on a new perspective: The mind develops from interactions between the individual and the environment, and as such, is embodied in these interactions. This perspective opens new explanations and predictions in the understanding and examination of the connection between cognition and behavior. For instance, reading the word *dancing* automatically may elicit activation in the brain's motor system required for dancing, and executing the act of *whistling* automatically may elicit activation in the brain's semantic system required to comprehend the concept of whistling. In other words, language and action are bi-directionally linked and share overlapping features that are recruited for understanding and doing. Rueschmeyer and colleagues explore and review empirical evidence for such a brain mechanism supporting language and action from the context of embodied cognition. Specifically, they discuss the concept of motor resonance to understand effects of language processing on motor systems, and introduce the concept of semantic resonance to predict effects of actions on language processing.

Working in the area of social cognition, we are very pleased with these new perspectives on language and action. In fact, research on social cognitive processes of behavior has a rich empirical tradition in showing that language and action entertain an intimate and reciprocal relation. Most of the studies in this domain have focused on effects of concept priming on social behavior. Thus, priming the concept of elderly has been shown to slow down participants' walking pace, due to an assumed overlap between representations of the stereotypical trait of slowness and corresponding motor programs associated with slow walking (Bargh, Chen, & Burrows, 1996). Moreover, concept priming has not only been shown to tune ongoing behavior; it also motivates behavior, such that people put more energy or resources in a task (e.g., squeezing more forcefully in a hand-grip) as a result of subtle exposure to words that change the concept of exertion into a positive or rewarding behavior the person wants to engage in (Aarts, Custers, & Marien, 2008). And there are many other demonstrations of this language effect on concrete action, even when the concepts are primed subliminally, outside of conscious awareness (see for an overview, Dijksterhuis, Chartrand, & Aarts, 2007).

Furthermore, there is also evidence for the reverse route—that is, action performance affects language comprehension processes. For instance, performing an overt behavior such as shaking one's head from left to right (or up and down) under the disguise of a fitness test of a headphone facilitates recognition and processing of evaluative congruent (i.e., negative or positive) words (Forster & Strack, 1996), and decreases (or increases) the effectiveness of attitude change in a persuasion context (Wells & Petty, 1980). In addition, manipulating bodily postures (e.g., sitting in either an upright or slumped position) affects reactions towards performance feedback in an achievement task (Riskind & Gotay, 1982). Whereas, these social cognitive demonstrations of a bi-directional link between language and action pertain to relatively abstract features of behavior, they concur with Rueschmeyer and colleagues' proposal that language processing affects motor systems through a process of automatic motor resonance, and action modulates language processing via a process of automatic semantic resonance.

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However, there is also an important difference between the social cognition research alluded to above and Rueschmeyer and colleagues' approach, and this difference is empirical as well as theoretical. Specifically, whereas most research in social cognition employs unobtrusive techniques to prime words or initiate action performance in studying reciprocal effects in language and action processing, Rueschmeyer et al. (and most of the other research they discussed to support their view) seem to use blatant instructions (without any cover stories) to encourage participants to explicitly process words or perform actions. This difference is not a coincidence, but pertains to the different role of intentions that both approaches assign to the process that enables language processing to affect action, and *vice versa*. Thus, social cognition research uses unobtrusive techniques, and elaborate cover stories, to rule out the role of conscious intentional processes, whereas, Rueschmeyer et al. seem to favor a pivotal role of intentions in studying the bi-directional link between language and action. Whereas, this difference is subtle, let us briefly explore the potential implications of semantic resonance as a result of intentional actions for our understanding of the concept of embodied cognition in the context of how action affects language processing.

First, consider the data that Rueschmeyer and colleagues discussed to support their view on semantic resonance due to action performance. In one study (Lindemann, Stenneken, van Schie, & Bekkering, 2006), action preparation before semantic processing was induced by instructing participants explicitly to move their hand towards or away from their body. After each movement, participants made a go/no-go lexical decision on fake words or real words. The data showed that moving a hand towards the body facilitated access to words representing objects that one can move toward the body (e.g., a cup), and moving a hand away from the body facilitated access to words representing objects that one can move away from the body (e.g., hammer). Another study offered suggestive evidence that this semantic facilitation of action-congruent words only shows up when participants make intentional movements rather than involuntary movements (Rueschmeyer, van Rooy, Lindemann, & Bekkering, submitted).

Note, however, that cups as well as hammers are usually brought towards and away from the body. Importantly, however, these actions differ in the functionality or reward that they bring about. For example, moving a cup to the mouth leads to quenching thirst, while moving the hand away from the body to get the cup serves the functionality of the action. In a similar vein, moving a hammer away from the body pushes the nail into the wall, whereas, the opposite movement is necessary to prepare a strike. This suggests that intentional movement may trigger in participants' mind a kind of interpretation process to deal with the question of why they perform the action or what it represents. Thus, representing the functionality or reward of the action facilitates language processing of the action-congruent objects, and not the mere activation of the motor program itself.

This observation is reminiscent of previous work in social psychology. In particular, Vallacher and Wegner's (1987; Wegner & Vallacher, 1986) action identification theory is a framework that is closely related to our current concerns. A central theme in this theory is that intentional actions (e.g., making a phone call) can be identified at various levels of abstraction. Specifically, if an action is identified at high-level of abstraction (e.g., contacting a friend), the goal it serves becomes highly accessible. If, however, an action is identified at a low-level of abstraction (e.g., using the phone) then more specific action-related features become accessible. Importantly, Vallacher and Wegner have shown that when both low-level and high-level identifications are possible, the high-level identity tends to become prevalent (Vallacher & Wegner, 1987; p. 5). Applying action identification theory to the present work, then, suggests that the semantic resonance is not an automatic process resulting from action-context, but is rather moderated by a conscious interpretation process in which participants try to make sense of what the action represents or why the action is performed. This line of reasoning raises the possibility that higher level cognitive processes intervene in linking action to language processing.

Although we do not wish to argue that intentions cannot play a role in priming effects of action on language processing, we only try to understand Rueschmeyer and colleagues' claim that intentional processes are required to find them. In fact, they discuss evidence that argues against such a conditional role of intention (Pulvermuller, Hauk, Nikulin, & Ilmoniemi, 2005). Pulvermuller and colleagues showed that sub-threshold (unintentional, involuntary) stimulation of effector-specific sites of the motor cortex (e.g., pulse of the foot area) facilitated processing of action-congruent verbs (e.g., kick). Whereas, these data show a direct link between action and language at the level of simple verbs rather than the utilization of tools in a specific context, they fit quite nice with the social cognition research on the link between action and language processing. Specifically, this research has demonstrated that the performance of action for an allegedly specific purpose (e.g., shaking ones heads up and down to test a headphone) modulates action-congruent processing of language (e.g., saying "yes" to a persuasive message), even though participants have a different intention to understand or identify the execution of the action (e.g., testing a headphone).

Thus, what seems to matter for semantic (or motor) resonance to occur is not so much the question whether the action is intentional, but whether the features of the motor and semantic representations that are available in our repertoire share sufficient overlap to jointly guide language and action (*cf.* for a similar account in the context of action-effect representations, Hommel, Musseler, Aschersleben, & Prinz, 2001). Actions, then, may facilitate action-congruent language processing independent of intentions when the overlap between motor and semantic representations is contextually specified or well-established, for instance in the case of habitual action or tool-use (e.g., Aarts & Dijksterhuis, 2000). When motor and semantic representations do not share specific or only weakly established features (e.g., a cup is as often brought to the mouth as it is put on a table), intentional processes may promote the understanding or identification of action performance in terms of its functionality or rewarding properties.

Summarizing, we believe that linking language to action by proposing automatic motor and semantic resonance principles makes much sense and provides a valuable contribution to the concept of embodied cognition. We also believe that the context constitutes an important aspect of these resonance principles. We question, however, the role of intentions in this process other than creating a context for the conscious understanding of actions, thus rendering an embodiment perspective on language and action less compelling.

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