Functional and neural dynamics of semantics for action

Michiel van Elk (m.vanelk@donders.ru.nl)
Donders Institute for Brain, Cognition and Behaviour
Radboud University Nijmegen, The Netherlands

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Much of our daily behaviour and many ordinary activities are implicitly guided by semantic knowledge that enables us to use objects in a meaningful way. However, as is the case with many cognitive abilities, the complex processes underlying our everyday actions (e.g. drinking coffee or driving a car) are usually taken for granted and not given much further thought (cf. van Elk, van Schie, Lindemann & Bekkering, 2007). To better understand the nature of the semantic representations that guide our actions, in a couple of recent studies we addressed the following questions: (1) what is the functional organization of semantics for action, (2) how do we acquire novel action semantics, (3) how do we flexibly select alternative semantic goals and (4) can we obtain insight in the neural and temporal dynamics of semantics for action.

First, in two recent studies it was found that semantic knowledge for action is organized in a hierarchical fashion around the prototypical goal- or end-locations at which objects are typically directed (van Elk, van Schie & Bekkering, 2008a; van Elk, van Schie & Bekkering, JEP:HPP, in press). Moreover, it was found that the retrieval of semantic knowledge is supported by the activation of functional motor programs that are highly associated with using the object (van Elk et al., in press). Interestingly, when learning how to use a novel object a comparable hierarchical organization was observed, which was strongly guided by the object's behaviourally meaningful action effect (van Elk, Paulus, van Schie, Pfeiffer & Bekkering, in revision).

However, in daily life we typically use objects in a flexible fashion, depending on one's current intentions and desires. For example, although a toothbrush is typically used to clean one's teeth, occasionally one may use an old toothbrush to clean one's bicycle chain. In a recent study, when subjects were instructed to use objects in an unusual fashion (e.g. bring a cup towards the eye) it was found that semantic representations could be temporarily overruled, depending on one's current action intentions (van Elk, van Schie & Bekkering; 2009). These findings suggest that semantic goal representations are selectively activated, according to the action intention of the actor.

Finally, in two ERP studies, the neural and temporal substrates of semantics for action were investigated in more detail (van Elk, van Schie & Bekkering, 2008b; van Elk, van Schie & Bekkering, submitted). It was found that only the preparation of meaningful actions (e.g. bringing a cup towards the mouth) resulted in an N400 priming effect for words that were congruent with the intended goal of the action (van Elk et al., 2008b). Furthermore, the preparation of meaningful actions was found accompanied by the retrieval of concrete semantic information, reflected in a stronger N400 component for meaningful compared to meaningless actions (van Elk et al.,. submitted). These findings suggest that semantic knowledge is selectively retrieved, only when a meaningful action is prepared.

In sum, the present studies provide new and exciting insight in the nature and organization of semantic knowledge for action and bring together different fields of study, such as action, language, memory and development..

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