

Is the acoustic modality relevant for abstract concepts? An investigation with implicit measures

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According to the grounded accounts of knowledge (Barsalou, 1999; 2008), concepts representation and processing is achieved by reactivating aspects of experience. This means that the concept “horse”, for example, gathers its meaning by the internal simulation or re-enactment of the sensorimotor experiences linked to a horse, such as seeing it, riding it, hearing its neigh, etc. Such a simulation would consist of the reactivation of the neural patterns that were also active when we experienced a horse.

Abstract concepts – concepts the referents of which are not material, perceivable, single, concrete entities such as “freedom” or “justice” – constitute a challenge for embodied and grounded accounts of knowledge. Since abstract concepts have no clearly identifiable referent that we can experience, explaining how they can be grounded in sensory-motor representations is not trivial.

One promising line of research integrates the grounded approach with a perspective that emphasizes the importance of language (e.g. Dove, 2010) in order to explain abstract concepts.

It is highly plausible that the contribution of language to conceptual processing is particularly crucial for abstract concepts and the corresponding words, given their lack of identifiable referents. It is possible that when we think of abstract words we internally reproduce their sound, re-enact the experience of their acquisition, and explain to ourselves their meaning.

These ideas are the core tenets of a recent proposal on abstract concepts: the Words As Social Tools theory (WAT: Borghi & Cimatti, 2009; Borghi & Binkofski, 2014). According to WAT, while both concrete and abstract concepts activate sensorimotor networks, the linguistic network is activated more by abstract than by concrete concepts given that the mode of acquisition of abstract concepts relies more on language. A recent fMRI study (Sakreida *et al.*, 2013) supports this hypothesis demonstrating that besides activating the core sensorimotor areas, abstract concepts activated part of the language processing system.

In addition, literature on mode of acquisition (MoA: Wauters *et al.*, 2003; Della Rosa *et al.*, 2010) shows that some words are mainly acquired through sensorimotor experience (e.g. “bottle”), while others are mainly acquired through linguistic inputs (e.g. “philosophy”). Since the physical environment is less efficient as a scaffold to support the acquisition of abstract concepts, language itself plays a scaffolding role for these concepts.

Furthermore, recent fMRI evidence (Hoffman *et al.*, 2015) confirmed that concrete concepts are more associated with visual experience whereas abstract concepts are more associated with acoustic experience, as revealed by the higher activation of dorsolateral temporal areas for abstract concepts and of ventromedial temporal areas for concrete concepts.

Whether the acoustic modality is actually relevant for abstract concepts has been the main focus of the present study. We conducted an experiment with the Extrinsic Simon Task (De Houwer, 2003). On some trials white words were presented whereas on other trials words were green or blue colored. Participants were instructed to press a left or right key in response to the content of white words and to the color of colored words. By assigning one response to vision-related white words (e.g., “bright”) and the other response to hearing-related white words (e.g., “echoing”), responses became extrinsically associated with visual and auditory content. We predicted to find a better performance when participants had to choose the extrinsically auditory response in response to a colored abstract word (e.g., “culture”) and when the extrinsically visual response had to be given in response to a colored concrete word (e.g., “horse”).

Mean Response Times (RTs) of the correct responses were submitted to a Repeated Analysis of Variance (ANOVA) with *Word* (abstract, concrete) and *Response* (auditory, visual) as the within-subject factors.

Provisional results show a significant two way interaction between Word and Response ($F(1, 40) = 5.726, p < .05, \eta_p^2 = .125$). Planned comparison show that Reaction Times for the colored words conveying abstract concepts were faster when the correct response was the response that was also assigned to auditory white words [688 ms vs. 711 ms, $p < .05$] and that Reaction Times for the colored words conveying concrete concepts were faster when the correct response was the response that was also assigned to visual white words [693 ms vs. 711 ms, $p < .05$].

This finding constitutes an implicit evidence that abstract concepts are grounded in sensory modalities and that they especially activate the acoustic modality, as predicted by the WAT theory.

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