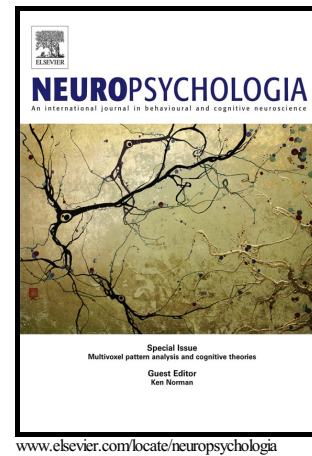


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**The neuro-cognitive representations of symbols: the case of concrete words.****Valentina Borghesani<sup>1,2,31\*</sup>, Manuela Piazza<sup>3</sup>**

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**Abstract**

We live our lives surrounded by symbols (e.g., road signs, logos, but especially words and numbers), and throughout our life we use them to evoke, communicate and reflect upon ideas and things that are not currently present to our senses. Symbols are represented in our brains at different levels of complexity: at the first and most simple level, as physical entities, in the corresponding primary and secondary sensory cortices. The crucial property of symbols, however, is that, despite the simplicity of their surface forms, they have the power of evoking higher order multifaceted representations that are implemented in distributed neural networks spanning a large portion of the cortex. The rich internal states that reflect our knowledge of the meaning of symbols are what we call *semantic representations*.

In this review paper, we summarize our current knowledge of both the cognitive and neural substrates of semantic representations, focusing on concrete words (i.e., nouns or verbs referring to concrete objects and actions), which, together with numbers, are the most-studied and well defined classes of symbols. Following a systematic descriptive approach, we will organize this literature review around two key questions: what is the content of semantic representations? And, how are semantic representations implemented in the brain, in terms of localization and dynamics? While highlighting the main current opposing perspectives on these topics, we propose that a fruitful way to make substantial progress in this domain would be to adopt a geometrical view of semantic representations as points in high dimensional space, and to operationally partition the space of concrete word meaning into motor-perceptual and conceptual dimensions. By giving concrete examples of the kinds of research that can be done within this perspective, we illustrate how we believe this framework will foster theoretical speculations as well as empirical research.

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