Brain mechanisms of concept representation and learning in brain and mind

Rosario Tomasello[1,2]

[1] Brain Language Laboratory, Department of Philosophy and Humanities, WE4 Freie Universität Berlin, 14195 Berlin, Germany
[2] Cluster of Excellence 'Matters of Activity. Image Space Material', Humboldt Universität zu Berlin 10099 Berlin,Germany

To grasp the meaning of words and their relationship to the outside world, higher cognitive processes unique to the human brain are at work. However, despite decades of research on the neural substrates of conceptual processing, a consensus about the functions and components of the semantic system has not been reached among neuroscientists [1,2]. Additionally, the unique striking ability of humans to *instantaneously* map a novel word together with its related referent, known as "fast mapping", poses several further challenges to research in the neurobiology of language and acquisition [3]. A fruitful approach to examining the brain mechanisms underlying conceptual representation and learning is the use of computational neural networks that resemble critical functional and physiological features of the human brain [4].

A biologically constrained cortex model that mimics the anatomical and physiological features of the frontotemporal-occipital regions [5–7] was therefore applied to simulate the learning of new words in the context of object perception and action execution, imitating typical language acquisition scenarios [8,9]. The simulations demonstrate that meaningful linguistic units in the brain are represented in the form of cell assemblies that have spontaneously arisen through the mutual interaction of a single set of biological mechanisms operating within specific neuroanatomical structures. Crucially, when implementing the model with a two-step learning process, equipping the networks with a pre-existing repertoire of referential and phonological representations before word meaning mapping takes place, it enables ultra-rapid associative semantic learning, as documented in empirical studies [10]. Overall, I will show that through the mutual effect of learning, cortical semantic areas and connectivity structure are sufficient to provide a straightforward explanation for conceptual representations in mind and brain and offer an account for the rapid semantic interlinking of phonological and conceptual circuits.

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