Online brain activation dynamics during novel word acquisition: EEG study

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Although the brain mechanisms of language acquisition are poorly understood, the existing literature suggests two main word learning strategies: implicit inference-based “fast mapping” (FM) vs. direct instruction-based “explicit encoding” (EE). To investigate brain dynamics of the word acquisition process and compare it between these strategies, we created a naturalistic audio-visual learning paradigm, in which the subjects were introduced to novel words (n=20) either directly (EE) or contextually (FM) using sentences containing names of unknown tools and animals in conjunction with novel images. We recorded word-elicited brain activation using EEG, and compared it between the beginning and the end of the learning session. Three most prominent ERP peaks were detected at ~125-150, 200-225 and 280-305 ms after the word onset; based on these ERPs, source-level cortical activation (LORETA) was computed. rmANOVA revealed a range of effects reflecting differential dynamics of the two learning types across all three peaks: in MTG, STG, and premotor areas at the first peak, premotor areas for the second peak, and IFG and MTG at the last one. Stimulus semantics (manipulable tools vs. animals) modulated activity in primary motor cortex at the first and third peaks, indicating the formation of distributed meaning-dependent memory circuits, in line with the embodied account of language processing. In sum, we document online temporo-frontal dynamics of new word memory trace build-up, which (1) takes place on-the-fly within a short training session, (2) involves core perisylvian language cortices and meaning-dependent modality-specific ones, and (3) depends on the acquisition regime, confirming at least partially different neural mechanisms of EE and FM learning.

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