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SINGLE-SHOT SEMANTIC MAPPING IN THE DEVELOPING BRAIN: THE ROLE OF ARTICULATION IN NOVEL WORD LEARNING

Young children are well-known as successful word learners, which is reflected in very high rates of new word-form acquisition and efficient mastering of the mother tongue or even several languages. This ultra-rapid lexical acquisition mechanism has been dubbed "fast mapping" [FM, Carey, Bartlett 1978]. Despite many studies conducted in this field, neural underpinnings of FM are still debated, and several open questions remain. Could single-shot semantic mapping be sufficient for rapid formation of novel word representations in the developing brain? To what extent does the activation of neural circuits outside the "basic language system" contribute to the word acquisition process in early development? To address these issues, we used ERPs to define brain dynamics elicited by novel words following a single-shot semantic associative learning task combined with sensorimotor (articulatory) training and to estimate cortical underpinnings of this process in the developing brain.

Healthy monolingual Russian preschool children (5–7 y. o.) performed a word-picture associative learning task [Vasilyeva et. al. 2019] accompanied by a brief articulation session. The task employed a counterbalanced set of familiar and novel words presented auditorily in conjunction with novel and familiar images appearing on the screen. A new word's meaning had to be inferred through a single-shot exposure to the novel item by excluding familiar items based on the semantic context. The child had to select the new object defined by the previously unfamiliar word form and then articulate the word form overtly three times. During the articulatory stage, the referred object was not displayed, to avoid the undesirable contribution of explicit learning. Acoustic stimuli were fully controlled dissyllabic (CVCV) word forms of two types: (i) four meaningful Russian words, (ii) four phonotactically and phonologically legal meaningless novel word forms (pseudowords). Visual stimuli consisted of two-dimensional photos of familiar and unknown objects. To define learning-related brain dynamics, passive auditory ERPs to newly learnt words were recorded immediately after the task, with familiar

words and untrained pseudowords used as control stimuli. Cortical sources were estimated using sLORETA algorithm.

ERP results revealed that a single-shot learning task combined with a brief articulatory training leads to significant decrease in fronto-central negativity, with a slight right-hemispheric shift. This decrease was present at 282–322 ms after the stimulus recognition point for both familiar and novel trained words, with no similar effect for control stimuli. sLORETA source analysis indicated that this activity was generated bilaterally in fronto-temporal areas, with maxima in BA21 (previously familiar items) and BA22 (newly learnt items).

Overall, our results demonstrate a rapid and highly plastic mechanism for word acquisition in the developing brain. Single-shot semantic learning task accompanied by brief articulatory training leads to an enhanced memory trace activation for both novel and familiar items, indicating rapid formation of new word form representations and possibly reinforcement of pre-existing ones for familiar words. Further research is needed to study neurocognitive mechanisms subserving efficient integration of perceptual and motor systems in the developing brain and its contribution to the word acquisition processes in early development.

References

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