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Electrophysiological Correlates of Statistical Learning in Children with and without Developmental Language Disorder

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Abstract : From an early age, exposure to a spoken language allows us to implicitly capture the structure underlying the succession of the speech sounds in that language and to segment it into meaningful units (words). Statistical learning (SL), i.e., the ability to pick up patterns in the sensory environment even without intention or consciousness of doing it, is thus assumed to play a central role in the acquisition of the rule-governed aspects of language and possibly to lie behind the language difficulties exhibited by children with development language disorder (DLD). The research conducted so far has, however, led to inconsistent results, which might stem from the behavioral tasks used to test SL. In a classic SL experiment, participants are first exposed to a continuous stream (e.g., syllables) in which, unbeknownst to the participants, stimuli are grouped into triplets that always appear together in the stream (e.g., 'tokibu', 'tipolu'), with no pauses between each other (e.g., 'tokibutipolugopilatokibu') and without any information regarding the task or the stimuli. Following exposure, SL is assessed by asking participants to discriminate between triplets previously presented ('tokibu') from new sequences never presented together during exposure ('kipopi'), i.e., to perform a two-alternative-forced-choice (2-AFC) task. Despite the widespread use of the 2-AFC to test SL, it has come under increasing criticism as it is an offline post-learning task that only assesses the result of the learning that had occurred during the previous exposure phase and that might be affected by other factors beyond the computation of regularities embedded in the input, typically the likelihood two syllables occurring together, a statistic known as transitional probability (TP). One solution to overcome these limitations is to assess SL as exposure to the stream unfolds using online techniques such as event-related potentials (ERP) that is highly sensitive to the time-course of the learning in the brain. Here we collected ERPs to examine the neurofunctional correlates of SL in preschool children with DLD, and chronological-age typical language development (TLD) controls who were exposed to an auditory stream in which eight three-syllable nonsense words, four of which presenting high-TPs and the other four low-TPs, to further analyze whether the ability of DLD and TLD children to extract-word-like units from the steam was modulated by words' predictability. Moreover, to ascertain if the previous knowledge of the to-be-learned-regularities affected the neural responses to high- and low-TP words, children performed the auditory SL task, firstly, under implicit, and, subsequently, under explicit conditions. Although behavioral evidence of SL was not obtained in either group, the neural responses elicited during the exposure phases of the SL tasks differentiated children with DLD from children with TLD. Specifically, the results indicated that only children from the TDL group showed neural evidence of SL, particularly in the SL task performed under explicit conditions, firstly, for the low-TP, and, subsequently, for the high-TP 'words'. Taken together, these findings support the view that children with DLD showed deficits in the extraction of the regularities embedded in the auditory input which might underlie the language difficulties.

Keywords : development language disorder, statistical learning, transitional probabilities, word segmentation
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