Digital Memory Encoding Characteristics in Chinese Dyscalculia

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Abstract
We know remarkably little about deficits in memory impairment calculation. This study reports the neurophysiological and behavioral correlates of digital memory encoding features in Chinese individuals with and without dyscalculia. The results showed that individuals with dyscalculia exhibit impaired digital memory encoding and deficits in psychological resource allocation.

Description
Developmental dyscalculia (DD) is a specific learning disability affecting the processing of numerical and arithmetical information in the context of normal intelligence (American Psychiatric Association, 1994), with prevalence estimates of the order of 5-7% [1]. Compared to normally achieving peers, DD children make more counting errors, exhibit problems in the execution of arithmetical procedures, and persist in the use of developmentally immature problem-solving strategies such as verbal or finger counting [2-4]. Despite growing interest observed in recent years, research on mathematical disabilities has progressed more slowly than that on reading disabilities. This is probably due to the complexity of the mathematical domain. Despite the high prevalence rates of developmental dyscalculia, our current knowledge about the neurocognitive and developmental characteristics of this learning disability remains limited. Moreover, most major theories about numerical cognition are derived from adult studies and consequently, many developmental studies are based on adult calculation models that may not be applicable to the developing brain.

Wang et al. employed an ERP paradigm to investigate the memory encoding Dm effect and the neural mechanisms of dyscalculia in children [12]. A total of 40 preadolescents who were screened from several primary schools in Kaifeng, China were tested; 20 were normal controls, and 20 had dyslexia. The age range of all preadolescent participants was 11.5–13.5 years (mean age 12.5). Differences wave showed early visual evoked potentials that occurred in the occipital region of P1 (average latency period of 96 ms), and this was followed by an early negative wave N1 (average latency period of 130 ms), and a P2 waveform (average latency period of 230 ms). The P2, mainly in the right occipital region, and the amplitude in the control group was significantly greater than in the dyscalculia group. The dyscalculia group P2 latency period (318 ms) was significantly later than that in the control group (284 ms) (F[1,17] = 14.06, P < 0.001). In the central area (taking Cz as the representative electrode), an LPC emerged at 351 ms and persisted to the end of the recording. The control group had a greater LPC than the dyscalculia group, which continued until the end of the stimulus. We found that both the dyscalculia and control groups exhibited a digital processing Dm effect, but that it was greater in the control group. Notably, dyscalculia memory-encoding defects were observed in the early stages of processing. Early memory encoding defects in children with dyscalculia may lead to the eventual failure of memory retrieval, and these retrieval defects lead to lower math scores. In addition, the encoding process requires the involvement of more mental resources, and children with dyscalculia cannot mobilize psychological resources (e.g., attention) well. Furthermore, there may be defects in their ability to allocate psychological resources, resulting in an insufficient processing capacity.

Although we found that digit memory computation impaired basic encoding features, we used fewer electrodes, so the precise spatial orientation of ERPs is still not clear. Future studies may perform multi-source analysis to identify more specific brain areas. For example, other reports have described different visual and auditory processing mechanisms. This study only assessed the effect of visual stimuli, and it is unclear whether auditory memory coding dysfunctions exist.
References


