Editorial

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# Developmental Dyscalculia of Digital Memory Retrieval

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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 retrieval features in Chinese individuals with and without dyscalculia. Children with dyscalculia and control groups were tested and their event-related potentials (ERPs) were digitally recorded simultaneously with behavior measurement. Behavioral data showed that the dyscalculia group had lower hit rates and higher false rates than the control group. The EEG results showed that both groups showed significant differences in digital memory retrieval in the frontal, central, parietal and occipital regions. These results suggest that individuals with dyscalculia exhibit impaired digital memory retrieval. Extraction failure may be an important cause of calculation difficulties.

**Keywords:** Developmental dyscalculia; Digital memory; Event-related potentials; Behavioral research; Learning disability

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## Editorial

Most diagnostic criteria use the term developmental dyscalculia (DD) to describe moderate to extreme difficulties in fluent numerical computation that cannot be attributed to sensory difficulties, low IQ or educational deprivation [1,2]. Epidemiological studies have shown that dyscalculia affects 3.5%-6.5% of school-age children [1,3] and often persists into adolescence.

Dyscalculia is caused by several cognitive deficits such as deficient working memory, abnormal visual-spatial processing or attention [4]. These were manifested as deficits in the retrieval of arithmetic facts from long-term semantic memory, in the execution of procedures for solving arithmetic problems and in the ability to represent or interpret visuospatial representations of mathematical information [5-7] reported various types of learning and short-term memory deficits in children with working memory deficits. Their results suggested that working memory and problem-solving accuracy were important for extracting knowledge from long-term memory. In recent years, studies having confirmed the fact that Dyscalculia is associated with retrieval and procedural deficits [8,9] have extended them to a potentially more fundamental deficits in numerical sense [4].

Recently, Wang [10] studied the Digital memory encoding in Chinese dyscalculia and found that both the dyscalculia and control groups exhibited a typical digital processing Dm effect which was greater in the control group. Notably, dyscalculia memory-encoding defects were observed in the early stages of processing. However, memory includes three separate but interacting processes: encoding, storage, and retrieval. Of them, the encoding and storage are the most active processes. Encoding refers to the initial process of the received information, producing the memory trace. Retrieval refers to the reactivation of the previous coded information. Many studies reported that the encoding and retrieval are based on different neural mechanisms, supporting the hypothesis that they are two separate phenomena. To date, it is still not clear whether retrieval defects exist in the later processing stage of children with DD. Despite the high prevalence rates of developmental dyscalculia, our current knowledge about the neurocognitive and developmental characteristics of this learning disability remains limited. Previous literature mostly was based on behavioral research, the time processing of memory retrieval remains unclear.

Event-related potentials (ERPs) can be measured to provide information about the neural mechanisms of memory retrieval in different stages of processing and these measurements can be compared to subsequent memory test scores. An effective

 

way to study memory retrieval is to use the old/new paradigm in which participants had to make judgments on whether a word or number presented in the test phase of the experiment had already been presented ("old") or not ("new"). The relative studies had shown that the positive amplitude of ERP elicited by words correctly judged as old is greater than positive amplitude elicited by words correctly judged as new , which was also called the old/new effects [11-14]. The old/new effects consist of three spatiotemporally and functionally distinct components. They are, in order of appearance following stimulus onset, the early old/new effect, the parietal old/new effect and the late frontal old/new effect [15-17]. In this study, we employed an ERP paradigm to investigate the digital memory retrieval old/new effect and the neural mechanisms of dyscalculia in children.

A total of 40 preadolescents who were screened from several primary schools in Kaifeng, China were tested; 20 were normal controls and 20 had DD. We found behavioral data showed that the dyscalculia group had lower hit rates and higher false rates than the control group. The EEG results showed that both groups had a significant old/new effect and this effect was greater in the control group. In the 300-400 ms processing stages, both groups showed significant differences in digital memory retrieval in the frontal regions. In the 400-500 and 500-600 ms epochs, the old/new effect in the control group was significantly greater than it was in the dyscalculia group at the frontal, central and parietal regions. In the 600-700 ms processing stages, both groups showed significant differences in digital memory retrieval in the frontal, central, parietal and occipital regions. These results suggest that individuals with dyscalculia exhibit impaired digital memory retrieval. Extraction failure may be an important cause of calculation difficulties.

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