Interventions of Children with Developmental Dyscalculia
Qiang WEI\textsuperscript{a}, Hua DONG\textsuperscript{b}, Jing WANG\textsuperscript{c} and Shang-Qing Li\textsuperscript{d}
School of Education, Jianghan University, China
\textsuperscript{a}weiqiang@jhun.edu.cn, \textsuperscript{b}angela-dong@jhun.edu.cn, \textsuperscript{c}921764849@qq.com, \textsuperscript{d}3502774726@qq.com

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\textbf{Abstract}. Developmental dyscalculia refers to the arithmetic difficulties, computing capacity significantly lower than its intelligence, age and education level should be at current levels at a young age. Based on many published literature, this paper collated and analyzed the influential factors of dyscalculia, including genetic inheritance, cognitive factors, environment, education and individual emotional factors, which may explain the causes of dyscalculia. Through systematic analysis and comparison, we summarized the results and combined them with our thinking to show you some efficient methods for interventions of dyscalculia and put forward the outlook to provide a more detailed review for future researches by pointing out their advantages and disadvantages of existing methods.

\textbf{Introduction}
Developmental dyscalculia was first proposed by Cohn in 1968. After it came out, this field began to attract great attention from researchers. Besides, many computational disorders are caused by other developmental disorders, such as dyslexia and ADHD. For computational disorders, traditional understanding is a clinical syndrome that shows low competence in the completion of mathematical tasks because of the inability to recognize the potential cognitive meaning of propositions. According to the ICD-10 and the DSM-IV \cite{1}, the main criteria for the development of computational disorders are: the development of general intelligence and the development of special mathematical abilities unbalanced, 5\textasciitilde7\% of school-age children have computational disabilities, which seriously affect children's schooling and life.

A mainstream report by the British government pointed out that the developmental dyscalculia is like a distant relative of dyslexia. But the social problems that may arise from developmental dyscalculia are comparable to dyslexia. The low numerical representation not only affects the life and work of the individuals but also greatly increases the expenditure of the state. If this ability is improved, it will bring great improvement to the national economy.

Recently, the research in cognitive and developmental neuroscience has provided a new way to understand the understanding of dyscalculia. They emphasize that the most lacking in children with dyscalculia is the correct understanding of qualitative and quantitative representations, which is precisely in primary mathematics teaching and learning. The interventions in the new research on enhancing the digital representation process of children are also gradually combined with the special education of children with dyscalculia and provide an effective theoretical basis.

About individual genesis, mathematical ability and heredity are highly correlated. Experiments have shown that in the early stages of babies, they can distinguish 2-3 objects. Therefore, researchers believe that arithmetic ability is an intrinsic trait of human beings. Scholars used the twin research paradigm or pedigree research paradigm and neurobehavior to conduct experimental research on dyscalculia, and the experimental results also support the genetic basis of dyscalculia to some extent. Also, the unilateral disorder of the brain also can be a cause of dyscalculia.

Other cognitive factors like working memory which is a bridge connecting short-term memory and long-term memory also play a key role in computing problems, especially the central execution system, voice loop, and visual space template.

From the theory of cognitive module disorders, the developmental dyscalculia is a problem in the
module that performs the computational function, and it will display various symptoms on the corresponding body of the patient who has dyscalculia. Dehaene[2] proposed the "triple code model" by adopting fMRI technology, and Anderson's[3]"minimum cognitive structure" theory interprets developmental dyscalculia as a result of a combination of unilateral disorders of the brain and cognitive module disorders.

Environmental factors, including environmental factors in the early stages of brain development, especially the maternal environment. Studies have shown that premature babies and children exposed to alcohol during the fetal period are more likely to have dyscalculia. Other factors including ineffective teaching methods and procedures, overcrowded classrooms, limited educational resources, family economy, insufficient attention, and mathematical anxiety can also have an impact on it.

**Intervention of Developmental Dyscalculia**

**Test Method**

Before the intervention, we need to know the ability of children to calculate. Currently, three test methods are commonly used. The *Wide Range Achievement Test* contains a computational Subtest which is a timed test that measures the achievement of a calculation. Shalev[4] compiled a set of computational tests based on the cognitive neural model of digital processing and calculation, which mainly measures the three aspects of numerical understanding, digital generation, and computational processing. *Neuropsychological Test Battery for Number Processing and Calculation in Children* [5] is a set of tests. It has been widely used in Europe to evaluate digital concepts, mathematical knowledge, and calculation procedures.

Besides, children's intelligence needs to be assessed. The intelligence level of children is usually assessed by the Wechsler Intelligence Scale to rule out the lack of computing power due to mental retardation.

**Behavioral Intervention**

Although behavioral training can work on, it is unclear which neuronal resources show a functional reorganization due to training. Somebody examined typically developing (TD) children and age-, gender-, and handedness matched children with DD before and after performing a number sequence task with fMRI and functional connectivity for 5 weeks of sequence training. Using the IPS as the seed region, DD showed hyper-connectivity in parietal, frontal, visual, and temporal lobe regions before the training controlling for age and IQ. After training, as math skills improved, hyper-connectivity disappeared. Multivariate classification analysis of task-related fMRI data confirmed the connection results, because the same group of TD can be distinguished from DD before sequence training, but not after sequence training. The results indicate that abnormally high functional connectivity in DD can be normalized on the neuronal level by intensive number line training. It proved that the intensive number of line training can be an effective intervention for dyscalculia[6].

In recent years, many computer programs have been developed for intervention in dyscalculia. In those games, the basic concepts are all based on the concept of number and quantity, but the emphasis is different. One category focuses on the improvement of non-symbolic quantity perception, such as number race; A kind of training that emphasizes more on the association between non-sign quantities and number symbols, such as graph game-math and number board game[7,8]. Some researchers use relatively complete models, which allows children to start from the perception and operation of non-sign quantity to the operation of abstract number symbols, and establish an overall process from non-sign to sign quantity, such as the Number Bond game[9]. Studies have shown that number disorientation and arithmetic operation confusion, which are common amongst the children displaying dyscalculia characteristics, were also significantly reduced after the intervention. This implies that the children benefited from the games.

The study of behavioral interventions has a relatively long process, and the specific measures of
intervention need to be based on a sound theoretical framework. Therefore, the targeted and migratory effects of current behavioral interventions require further time and in-depth research to confirm. Recently, researchers have begun to try a new approach to intervention. A recent study by Cohen-Kadosh found that use Transcranial Direct Current Stimulation (TDCS) to apply a brief microcurrent to the parietal lobe can improve the performance of the subject's digital learning and it lasts up to 6 months. The study found that applying the anode stimulus to the right parietal lobe during training and applying the cathode stimulus to the left parietal lobe have a better and more stable effect on different types of digital learning tasks. This method based on brain science research and intervention from the biotechnology to solve dyscalculia presents new ideas beyond behavioral promotion methods. However, the persistence and migration of the effect, the deeper mechanism of the effect, the further refinement and determination of the parameters of the method are to be further verified and improved.

**Psychological Intervention**

Considered as a part of learning disabilities, dyscalculia can also be alleviated by universal psychological methods for learning disabilities, and there are many mature therapies for children with learning. Researchers found that the subjective quality of life of children with dyscalculia is worse than that of normal children. Same as the children with learning disabilities, the satisfaction of family and school life, living environment and self-awareness are lower than that of normal children. These factors may lead to more obstacles in learning attitudes, motivation, and self-awareness. Therefore, mobilizing the enthusiasm of children with dyscalculia, helping them establish a positive self-concept and stimulate their motivation. This has important practical significance for preventing and reducing children’s learning disabilities. Du Gaoming found that psychological health education researchers and psychological counselors use psychological therapy theory and methods to regularly conduct collective psychological counseling on problems of students with learning disabilities and individualized counseling for individual cases. Teachers with special education experience use good educational methods and methods to manage children in their usual education and teaching work, including cognitive training, learning strategies, encouragement and computer-assisted instruction (CAI). Parents cooperate with the school to carry out various educational activities and learn the correct way of tutoring is also helpful.

**Conclusion**

In brief, so far, researches on developmental dyscalculia have matured. Scientists have dug out the causes and the factors that influence it from different fields of study. Dyscalculia can be caused by genetic defects, left and right cerebral dysfunction, and mental dysfunction, and is accompanied by impaired cognitive and memory abilities, and shows imperfect or inefficient cognitive abilities in the calculation process. Researchers have also discovered many theoretical models that explain the computational mechanism of the brain, including the triple code model and working memory theory.

Based on a clear understanding of its causes, we distinguished interventions that include three directions, physical behavior training, physiological interventions and psychological and educational intervention. Like many other developmental handicaps, the earlier people with developmental dyscalculia intervene, the better their ability to recover. However, the current objective progress cannot be reason to stop. We should apply advanced technology to treatment and intervention of dyscalculia as mentioned in some researches, artificial intelligence technology, and human-computer interaction systems combined with principles of intervention may provide a more convenient, comprehensive, and effective method to treat it.

**References**