mind, the American psychologist John B. Watson, following in Ivan Pavlov's footsteps, emphasized the importance of conditioning. He believed that study of behavior is the only reliable way to gain understanding. [1] Behavioral therapies, therefore, have traditionally focused on changes in behavior and symptom relief rather than on self understanding. Behavioral therapies, like dynamic therapies, have become increasing refined throughout the twentieth century and into the present, (progressing from Skinner's work to current cognitive-behavioral theories and techniques) and increasingly have embraced concerns about self understanding and personal responsibility.

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Dyscalculia

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Synonyms

Learning disability in math; Math deficit; Math difficulties; Math disorder; Math dyslexia

Definition

Dyscalculia includes a wide variety of math difficulties including the inability to comprehend the meaning of numbers and their quantities, and the inability to comprehend basic addition, subtraction, multiplication and division calculations. Acalculia refers to the total inability to do math, whereas, dyscalculia refers to less severe difficulties in performing math problems.

Description

Dyscalculia is thought to involve problems with language and visual centers of the brain. Theories have suggested that it may either be inherited or may be due to insults in normal brain development such as prenatal or environmental toxins. Proof of a genetic component has been shown in studies of monozygotic and dizygotic twins which demonstrated that MZ and DZ twins were 12 and 8 times more likely, respectively, to have dyscalculia than the general population. Preterm birth and low birth weight have also been cited as risk factors for the development of dyscalculia. Some suggest that poor teaching and environmental deprivation may also be implicated in its etiology.

The term "developmental dyscalculia" (DD) has been created to distinguish the problem of dyscalculia seen in children from that evident in adults following specific insults to the brain.

Studies have estimated that approximately 3–6% of the population is affected by DD. It is seen equally in both boys and girls, despite the fact that learning disabilities are generally more prevalent in boys. Dyscalculia, like dyslexia, usually becomes evident during the first few years of grade school. It has been associated with a number of co-morbid conditions such as attention deficit and hyperactivity disorder (ADHD), anxiety disorders, Fragile X syndrome, Turner syndrome, Gerstmann's syndrome and epilepsy.

Of those children with DD, only about 1.8% possess pure DD. The remainder have comorbid dyslexia, as well. Aster and Shalev [2] suggest that this is due to a difference in the pathophysiology. In those with pure DD, there is most likely a genetic predisposition resulting in a numerical core-system deficit. Those with combined dyslexia and DD likely possess additional mechanisms which involve delayed speech and language development.

One classification scheme for dyscalculia divides it into five subtypes: [1] alexia and agraphia for numbers [4] spatial dyscalculia [5] anarithmetia (loss of numeric values or their manipulation) [6] attentional sequential dyscalculia and [7] mixed type. Although these distinctions are rarely utilized clinically, it allows one to better comprehend the spectrum of difficulties that those with DD may encounter.

Neuroimaging affords researchers the ability to localize areas of deficit in children with DD. Typical children tend to show activity mainly in the left frontal and parieto-temporal regions of the brain. However, patients with DD tend to show defects in the left parieto-temporal area. Additionally, when participants with DD were asked to perform certain arithmetic tasks, the intraparietal sulcus and left middle frontal gyrus were highlighted as the most active areas of the brain. In contrast, controls showed activation of the intra-parietal sulcus bilaterally and minimal activation of the left frontal gyrus. Further imaging studies have suggested that children with DD attempt to

recruit "substitute" regions of the brain to compensate for the lack of normal activity. Unfortunately, these efforts are typically ineffectual.

A number of theories have been proposed to explain the development of DD. According to some, there are three underlying origins of dyscalculia. The most common is a visual processing weakness. Visualizing numbers and situations is crucial to the proper understanding of math. People with a weakness in visual processing often have difficulties with spelling and handwriting, as well. The second origin is difficulty in sequencing or in organizing specific pieces of information, a necessary task in mathematics. People with sequencing difficulties often also experience difficulty with memorization in general which may lead to spelling weaknesses, as well. The final origin is simply a phobia of math. This may be due to prior negative experiences, an inconsistency in one's education, or merely a lack of confidence.

Others postulate that the cause of DD is related to a defect in the acquisition of skills necessary to carry out mathematical operations. The first of these is *foundational skills*. This involves visual perception, visual memory and logical thinking. Children with DD may have difficulty with visualizing and distinguishing mathematical symbols such as +, −, ×, ÷. The second aspect is *mathematical skills*, concepts that must be learned such as counting, addition and subtraction. These skills must be learned in a sequential fashion – one cannot add or subtract until one first learns how to count. If skills are not mastered in the proper order then subsequent steps cannot be grasped correctly. The third piece is *knowledge*, ideas that a person must simply know. For example, theorems and definitions must be learned and remembered.

Another theory proposes that number acquisition occurs by a four-step process and that DD is due to a defect in this mechanism. The first step that takes place is inherited. It involves number sense and the ability to discriminate small sets of objects from large sets of objects. This skill is present from infancy and is necessary for the proper progression of number acquisition. It provides the basic meaning of numbers. If step one fails to be established (possibly due to genetic vulnerability), then children may be able to memorize the names of numbers, but may be unable to assign numerical value to those names. The second step, which occurs during the preschool years, involves the process of language development for numbers. Children with deficits in this stage have difficulty in counting and in sequencing of number word elements (i.e., 235). Because stage two entails a language component, children who don't fully develop language properly, may also have comorbid dyslexia. The third step entails the acquisition of the respective symbols for each of the numbers. This occurs during the early schooling years. It is important to properly progress through this stage so that a child can distinguish similar numbers (i.e., 25 versus 52). A failure to develop an appropriate system of symbols results in an inability to progress to the fourth step, which allows one to create a mental number line. This provides a representation of the ordinal position of numbers.

People with DD may demonstrate a wide array of symptoms, depending upon their age. Some may have difficulty in performing certain mathematical tasks whereas others may find it difficult to understand arithmetic concepts. Additionally, those with DD may reverse or transpose numbers – i.e., 56 instead of 65; 743 instead of 437. Other manifestations include difficulty in using a calculator, difficulty with counting money and with financial planning, and an inability to judge the passing of time. Some children may show a poor sense of direction and may also have difficulty in estimating the measurement of an object – i.e., approximating the distance from point A to point B. Although people with dyscalculia have difficulties in understanding concepts related to numbers, their general ability to learn is equal to, or even greater than that of their peers.

The diagnosis of DD is based upon an assessment of the child's arithmetic skills. If there is a significant difference between the child's intellectual potential and his or her arithmetic achievement or if there is a discrepancy of at least 2 years between the child's chronological grade and his/her level of achievement, then a diagnosis of DD can be made. Standardized arithmetic tests are the acceptable methods to assess a child's abilities. During the process of diagnosis, it is imperative that one determine whether DD is a primary diagnosis or a symptom of a greater disorder (i.e., Fragile X syndrome). Moreover, comorbidities should be carefully identified so that they may be treated, as well.

Treatment of DD relies upon a number of factors. Nonacademic skills are important to all students, especially those with learning disabilities. These skills include assuming accountability for one's own behavior, arriving prepared for lessons, meeting deadlines, maintaining appropriate school behavior, following directions, and completing homework assignments. Refining these skills can have long-term benefits. Children with syntactic deficits with numbers require verbalization of concepts. For example, in order to fully comprehend the number 47,632, it will need to be stressed to the child that the "4" represents the ten thousands place, the "7" the thousands place, the "6" the hundreds place and so on and so forth. Interactive learning

tools like the MASTER (Mathematics Strategy Training for Educational Remediation) program can help children with DD to comprehend the concept of mathematical operations. This program utilizes the idea that children with DD can learn arithmetic when provided with number concepts and problem-solving strategies. Additionally, assistive technology such as calculators, digital clocks and calendars should be made available to children with DD.

There is little information regarding the prognosis of dyscalculia. However, fifth grade boys and girls with DD who were followed for 3 years were found to perform in the lowest quartile of their class in 95% of cases. Forty-seven percent of them performed in the lowest fifth percentile. Factors associated with the persistence of symptoms are the severity at initial diagnosis and the presence of arithmetic difficulties in siblings.

Relevance to Childhood Development

Dyscalculia can affect people in different ways in school and throughout their life.

Dyscalculia can be identified at a young age, although it may go unrecognized because it is a less well-known learning disability. According to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR) [1], children with below average intelligence can be classified as having mathematics disorder if math ability falls substantially below that expected for the student's chronological age, measured intelligence, and age-appropriate education. Dyscalculia is often initially identified by a teacher when a student is struggling in school, and subsequently the student is assessed by a professional trained in identifying learning disabilities.

In the early years of school, students with dyscalculia may have difficulty solving mathematical equations, remembering and retaining math facts, and understanding how to apply their knowledge and skills to solve math problems. If basic mathematical facts are not mastered, this can result in difficulty for adolescents and adults in mastering more advanced math problems. When students need special education, special services are provided by the school under the category of Specific Learning Disability (SLD).

Math interventions for students are emerging for both foundational math skills and higher-order problem solving skills. Interventions for math disabilities often consist of not only skills training, but also explicit instruction in strategies such as self-regulation and mnemonic devices [5]. Deciding which interventions to use is a highly individualized process that is dependent on the student's developmental level, current math skills, and requirements of the school district's math curriculum.

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Dysgraphia

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Synonyms

Agraphia; Disorder of written expression; Handwriting; Spelling disabilities; Writing learning disability or specific learning disability (LD)-written expression

Definition

Writing is a complex skill that combines elements of visual-motor coordination, fine-motor coordination, and executive planning. Dysgraphia is a term that is used to describe an inability to produce legible text with minimal effort, and is generally used to describe a disorder of written expression with an onset during childhood.

Description

The research on disorders of written expression is very limited and has been hampered by definitional issues such