

Learning
Starts Early!

Learning Disabilities: Dyscalculia and Dyslexia



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Early Childhood Learning Knowledge Centre

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The mission of the ECLKC is to gather and disseminate knowledge about early childhood learning that will help to improve the quality of environments for young children and optimize their learning conditions.

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“Dyscalculia and dyslexia are the two main types of learning disabilities that can affect school-aged children.”

Learning Starts Early!

Learning Disabilities: Dyscalculia and Dyslexia

Dyscalculia and dyslexia are the two main types of learning disabilities that can affect school-aged children. Also known as mathematical disability, dyscalculia refers to a persistent difficulty in learning or understanding concepts related to numbers, counting, and arithmetic.¹ Dyslexia refers to difficulty with respect to reading and writing.² In both cases, the deficits are ‘unexpected’, meaning the child seems to have the capacity, the motivation and the adequate instruction to learn these concepts, but still struggles to do so.²

Interventions for learning disabilities work best when initiated early in life, usually around the preschool years. Identifying at-risk children this early poses a major challenge, however.³ The signs of trouble are not always clear. For example, children who appear to have good language development in their first years of life may show signs of dyslexia only after they begin to learn to read, and some children who initially struggle with reading eventually rally and never develop dyslexia.²

Both dyscalculia and dyslexia are serious public health concerns. Without help, children with learning disabilities could develop persistent problems with learning. Although most children with learning disabilities grow up to be productive citizens, left untreated these conditions have been associated with a higher risk for mental illness, social and emotional problems, behaviour problems at school, and time in prison.⁴

Dyscalculia

An estimated 4 to 7% of school-age children show characteristics of dyscalculia.⁴ The hallmark of the condition is difficulty with basic math skills and knowledge, including:

- **Basic number concepts** – e.g., knowing that ‘9’ = ‘nine’ or $9 > 8$. Children with dyscalculia tend to be delayed in acquiring these concepts.¹
- **Counting** – e.g., understanding the principles of counting and using them to count accurately and flexibly. Children who do poorly in mathematics sometimes appear to have an incomplete understanding of counting and, consequently, persist longer than their peers in counting in an inflexible manner (e.g., proceeding from left to right and insisting that any other order is incorrect).¹
- **Number combinations** – e.g., having unusual difficulty remembering basic arithmetic facts, such as $3 + 5 = 8$, and relying excessively on immature problem-solving strategies.^{1,4}
- **Word problems** – e.g., having difficulty solving arithmetic problems in the form of linguistically presented questions, sometimes including irrelevant information, for which answers require adding or subtracting (e.g., Sally has two apples. Mary gives her eight more, but Ken eats one. How many does she have?).⁴

Ongoing difficulty with these skills can impair learning for years to come because they form the foundation from which new skills can be learned.⁴ Another important consequence of untreated dyscalculia is that it can lead to anxiety about and avoidance of mathematics. This may, in turn, contribute to increased difficulty learning mathematics.¹ Continued impairment in mathematical ability not only can affect school performance but also can have a negative impact on employment, income, and work productivity.³



“In fact, as many as 75% of children who struggle to read in Grade 3 will continue to struggle throughout high school.”²

Dyscalculia (continued...)

Intervention Strategies

Unfortunately, very little research has been conducted on intervention strategies to help children with dyscalculia, particularly among children in the early primary school years.¹ However, four approaches that, at least conceptually, could be beneficial are:

- **Conceptual instruction:** The teacher structures experiences in an effort to foster interconnected knowledge about quantities. The underlying assumption is that number combination skills will emerge as meaning and concepts about numbers are strengthened.⁴
- **Drill and practice:** Repeating simple math problems until they are memorized. The assumption here is that once fundamental math problems are memorized, basic errors no longer impose a barrier to more advanced learning.⁴
- **Meta-cognitive instruction:** The teacher helps students break down word problems into discrete, solvable steps.⁴
- **Schema-based instruction:** Students master the rules for solving different word problem types and then learn to identify which solving strategies apply to which types of problems.⁴

Because these approaches have not been studied closely, it remains unclear which are most effective, nor is it known whether they offer long-term benefits.⁴ Available research indicates, however, that children will likely benefit most from a combination of approaches.^{3,4}

Early Identification

Even though widely recognized signs of dyscalculia only emerge after children enter primary school, it is important to realize that early identification is still possible.³ Signs of dyscalculia in preschool children include not knowing basic number names, having difficulty understanding quantities of small numbers (i.e., numbers < 4), having difficulty counting small sets of objects, and not understanding simple additions and subtractions.¹ It is therefore possible to develop standardized diagnostic tests for dyscalculia in children of preschool age. Such tests are needed so that at-risk children can benefit from early intervention.¹

Dyslexia

Contrary to the popular notion that early readers having difficulty will soon catch up to their peers, evidence demonstrates that early reading problems are a sign of persistent dyslexia. In fact, as many as 75% of children who struggle to read in Grade 3 will continue to struggle throughout high school.²

Rates of dyslexia vary depending on the primary language being learned, as languages with more difficult orthographies are associated with higher rates of dyslexia. For instance, among children learning Finnish, only 3 to 6% suffer from early reading problems, while more than 10% of children learning to read English face significant problems.³

Unlike speaking, reading is not a natural skill; it needs to be taught. To learn this skill, children must master five key elements of reading:

- Phonemic awareness, or the ability to understand that words are made of the discrete sounds, or *phonemes*;
- Phonics, or the ability to link letters to specific phonemes;
- Fluency, or the ability to read rapidly and with good understanding;
- Vocabulary;
- Reading comprehension.



“Certain foundation skills for reading, such as understanding the sound structure of oral language and letter knowledge, begin in the preschool period.”²

Dyslexia (continued...)

Children with dyslexia generally have trouble with phonological processing, that is, using phonological information, especially the sound structure of oral language, in processing written and oral language.⁵ Recently, brain imaging studies have demonstrated a biological basis to this difficulty. During reading exercises, good readers show activity in three areas on the left side of the brain. In dyslexic readers, there is much less activity in two of these three areas.²

There is strong evidence that both environmental and genetic factors affect the likelihood that a child will develop dyslexia.³ Environmental influences can include the complexity of the orthography of the language being learned³ as well as reduced stimulation experienced by children from disadvantaged backgrounds.⁶ The influence of genetics on the risk for dyslexia has been made clear in studies demonstrating that children with parents, siblings, or other close relatives who have dyslexia are at dramatically increased risk of developing the condition themselves.³

Intervention Strategies

Among children with dyslexia, early intervention is crucial. Left untreated, reading difficulties generally continue throughout development.² The long-term impact of ongoing reading problems include reduced motivation for learning, lower self-esteem and emotional well-being³ as well as increased rates of mental illness, social and emotional problems, behaviour problems in school, and antisocial behaviour.⁶

Strategies for preventing dyslexia among at-risk children can begin as early as the preschool period because reading foundation skills, such as identifying phonemes and associating them with specific letters, actually begin in the preschool years.

Intervention strategies should be based on what is known about dyslexia from the scientific literature. In this light, activities that emphasize phonological awareness, understanding that words are made of distinct sounds, are important. Activities such as games that involve rhyming, clapping along with syllables, and the breaking down and blending of words can be effective.² Also useful are training activities that focus on the connections between written and spoken language units, beginning with learning the most frequent and dominant letter-sound combinations.³ Importantly, these activities can be presented to children in a manner that is fun and engaging.^{2,3}

The brain imaging studies that have identified differing brain activation patterns in good and poor readers can be used to evaluate the usefulness of treatments for dyslexia. For example, systematic, organized teaching methods that focus on instructing children on the five basic elements of reading, helping children relate letters to specific sounds, and deconstructing and reconstructing words, have been shown to increase activation in the brain areas that are less active in poor readers.²

It is important to remember, however, that children with more severe reading difficulties will require more intense and explicit training than what is described here.⁶

Early Identification

The identification of children at risk for dyslexia should be based on both a failure to develop reading foundation skills and on the presence of a family history of dyslexia.³ Children with familial background of dyslexia should be monitored regarding their language development starting at age two.⁶

Certain foundation skills for reading, such as understanding the sound structure of oral language and letter knowledge, begin in the preschool period.² As a result, this period presents an ideal opportunity to identify children likely to develop reading problems and offer remediation before reading problems affect school performance and attitudes toward reading.³ If the child is not able to learn at least some letters of the alphabet at three years of age, there is a reason to recommend some enhanced training on these skills. An important later sign is poor phonological awareness. By age five, children should have some capacity to rapidly name familiar symbols such as colors, objects, numbers, and letters when presented in sequence. The combination of poor letter naming skills at age three and poor rapid naming skills at age five is a good sign that a child will develop dyslexia.^{3,6} Such high-risk children require at least 20 minutes a day of systematic practice of reading foundation skills.³



“Early identification is the key to preventing reading- and math-related learning difficulties in school-age children.^{1,4,6}”

Conclusion

Early identification is the key to preventing reading- and math-related learning difficulties in school-age children.^{1,4,6} The most successful interventions employ a combination of approaches and strategies.^{4,6} These interventions should begin in early childhood in order to avoid the emotional difficulties, behaviour problems, and loss of motivation to learn that can accompany learning disabilities. The earlier the intervention, the fewer failure experiences a child will experience at school.⁶

Additional attention must be given to the co-occurrence of math and reading difficulties and their relation to anxiety and school avoidance.¹

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