SMC Research Summary
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Dyslexia

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What Is Dyslexia?

Dyslexia is a neurodevelopmental disorder. This means it is heritable, lifelong and presents in early age, often at preschool. Dyslexia is a difficulty in learning to decode (read aloud) and to spell. It is important to note that when dyslexia is referred to as being heritable, this refers to inheriting an increased likelihood of dyslexia only; it does not guarantee that a child will have a reading problem. Further, just because dyslexia is partially heritable, that does not mean it cannot be ameliorated.

The diagnostic criteria refer to a *Specific Learning Disorder with impairment in reading* to describe what others call 'dyslexia': a pattern of learning difficulties characterised by problems with accurate or fluent word reading, poor decoding, and poor spelling "*that must have persisted for at least 6 months, despite the provision of interventions that target those difficulties"* (American Psychiatric Association, 2013). However, many reading researchers propose that the term 'dyslexia' should not be used in this way, to encompass *all* reading disorders, but should be used to refer *specifically* to a difficulty with *decoding* and *spelling fluency,* which is evident from the early school years and persistent over time. For diagnosis, the difficulty should affect academic functioning, such that progress is less good in literacy-based areas of the curriculum than that of peers in a similar setting. In addition, co-occurring problems should be labelled as such but not considered core to the diagnosis (Snowling, Hulme & Nation, 2020).

Varying approaches to diagnosis and assessment (Snowling, Hulme & Nation,2020) and co-occurring conditions make prevalence difficult to gauge, but estimates between 3 and 7% are common (Snowling & Melby-Lervåg, 2016). However, some estimate that up to 20% of the population are affected (Shaywitz et al. 1992; Wagner et al. 2020). The diagnosis is more common in boys (Moll et al. 2014).

Dyslexia is a lifelong condition. Children who are slow to develop reading skills are at high risk of under achievement during school and later in life. The Connecticut longitudinal study with 445 adolescents found that those identified as poor readers at the age of 7 were still identified as such aged 14 (Shaywitz et al., 1999). When fifty 13–14-year-olds at familial risk for dyslexia were assessed, 42% had reading and spelling deficits (Muter & Snowling, 2009). In an analysis of the 1995/6 UK student database 0.42% of students had a dyslexia diagnosis. These students were less likely to complete their degree or if they did, they tended to achieve a lower class of degree. However, 40% of those with dyslexia achieved a First or Upper Second, demonstrating the positive impact of effective resources provided by the institution (Richardson & Wydell, 2003).

Children with dyslexia are also at risk of slower verbal language acquisition and slower growth of world knowledge across their lifetime as a result of reduced reading experience; a phenomenon known as the *Matthew effect*. For example, in a longitudinal study with 485 children Duff, Tomblin & Catts (2015) found widening gaps in vocabulary knowledge between the ages of 9 and 15 years. Additionally, they are at risk of developing socio-emotional behavioural problems, low self-esteem, and mental health problems such as anxiety and depression (Livingston, Siegel, & Ribary, 2018).

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Common Strengths

The effects of dyslexia on literacy can be reduced by strong oral language skills (van Viersen, de Bree & de Jong, 2019). A positive home literacy environment, family and peer support and higher socio-economic status are protective factors (Catts & Petscher, 2020). Early identification and intervention can reduce the impact of dyslexia on literacy and on self-esteem (Hulme & Snowling, 2016). Unsurprisingly, the quality of instruction has also been shown to be an important factor (Burden & Burdett, 2005). Personal characteristics such as resilience and a positive mindset are also important compensatory factors (Haft, Myers & Hoeft, 2016).

Though some small studies have shown that adults with dyslexia might have enhanced abilities (for example Attree, Turner & Cowell, 2009), other more robust designs have shown there is no strong evidence for enhanced intelligence, (van Viersen et al. 2015), creativity (Majeed, Hartanto & Tan, 2021) or visuo-spatial skills in children with dyslexia (Chamberlain et al. 2018). That said, for a child with dyslexia as for any child, taking the time to find areas of interest and talent is likely to have benefits in terms of self-esteem and motivation. For those with dyslexia, areas that don't traditionally require a lot of reading may be a fruitful place to focus on and cultivate.

Common Challenges

It is now established that dyslexia is caused by problems in dealing with the sounds of speech: phonological skills. These include perceiving speech sounds accurately combining them to make words and then mapping them to the visual letter symbols. Examples of tests to measure phonological awareness include phoneme matching - *"find the pair that start with the same sound from 'sheep, pen, pig'"* or rime matching - *"find the pair that end in the same sound from 'pin, tin, pen'"*. In some cases, poor phonological skills may arise from an underlying problem in oral language. Longitudinal studies show that preschool variations in oral language are associated with word reading problems in 8–9-year-olds (Snowling & Melby-Lervåg, 2016).

Other related problems are difficulty learning new spoken words, poor short-term memory for spoken words and problems with finding words (phonological retrieval) and picture naming. There is good evidence that these phonological difficulties in dyslexia are present in the preschool years, long before reading instruction begins (Snowling et al. 2019). However, there is heterogeneity in how children present with dyslexia. For example, Kohnen and colleagues (2012) found that a sub-group of children with dyslexia had a specific problem in letter position coding in words where precision is needed, for example, (e.g., *pirates* and *parties; smile* and *slime*). Others will have severe problems across the areas listed above.

While the case for the phonological deficit as a key cause of dyslexia is established, other explanations attempt to explain how this difficulty might arise. Catts & Petscher, (2020) suggest that, for example, problems in visual processing or attention may cause reading difficulty. A growing body of research considers whether more general learning mechanisms such as statistical learning, (our ability to notice and track how often sounds/words/groups of words appear in language) may play a causal role in dyslexia (Nation & Mak, 2019).

About 40% of children with dyslexia will have a co-existing condition (Moll et al, 2014). These can include problems with handwriting (dysgraphia), problems with attention and motor coordination, or issues in the socio-emotional and behavioural domain. Internalising problems such as anxiety and depression may also co-occur. It is important to note that none of these problems are core features of dyslexia, but they can affect how a person presents or responds to interventions. Mathematics disorder or dyscalculia accompanies dyslexia in between 30-70% of cases (Landerl & Moll, 2010).

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The Evidence on Supports

Intervention programmes focusing on training in the speech sounds of language and letter awareness have been found to be the most successful in helping people with dyslexia (Bowyer-Crane et al. 2008, Hulme et al., 2012). These should be combined with structured reading practice, as evidenced in a randomised controlled trial (Hatcher et al. 2006).

Spelling interventions including phonics, spelling rules and morphological instruction (developing awareness of how the smallest units of meaning fit together: 'draw-ing') have been shown to have moderate to high impact on spelling performance in a systematic review (Galuschka et al. 2020).

Reading exposes a child to rich and varied language, so to avoid the *Matthew Effect*, a child with dyslexia will also need exposure to wide-ranging vocabulary and language to acquire knowledge about the world. Audiobooks provide advanced language and information without the effort of decoding, may increase independence, and can help with reducing emotional and behavioural problems that may accompany dyslexia (Milani, Lorusso & Molteni, 2010).

More research is needed on the effectiveness of interventions to improve writing fluency and into programmes to tackle the co-existing problems people with dyslexia may have, particularly in oral language.

There is no strong evidence that specially designed fonts, coloured glasses, or overlays improve reading skills in children with dyslexia, (see for example Henderson, Tsogka, & Snowling, 2013; Marinus et al., 2016).

What's Next in Research?

One novel approach is to deploy video games to improve visual attention span. These have shown some promise in improving decoding ability in dyslexic children (Franceschini & Bertoni, 2019).

Much of current cutting-edge research focuses on neurobiological methods of understanding dyslexia. Research into the genetic basis of dyslexia is ongoing; to date several candidate genes have been identified (Gialluisi et al. 2020).

Different patterns of activation and less grey matter (brain tissue) have been found in the brains of people with dyslexia: the temporoparietal regions active in decoding and the occipitotemporal regions involved in sight word reading (Kearns, Hancock, Hoeft, Pugh & Frost, 2019).

Research is ongoing into whether people with dyslexia have impairments in the temporal processing system of the brain which processes both visual and auditory information (for example: Casini, Pech-Georgel & Ziegler, 2018). It is suggested that deficits in temporal processing disrupt accurate sequencing of the order of letters and sounds in a word, thereby causing the weak phonological skills commonly seen in dyslexia (Stein, 2018).

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