



## Defining and understanding dyslexia: past, present and future

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### ABSTRACT

Dyslexia is a difficulty in learning to decode (read aloud) and to spell. DSM5 classifies dyslexia as one form of neurodevelopmental disorder. Neurodevelopmental disorders are heritable, life-long conditions with early onset. For many years, research on dyslexia proceeded on the basis that it was a specific learning difficulty – specific meaning that the difficulty could not be explained in terms of obvious causes such as sensory problems or general learning difficulties (low IQ). However, the failure to find qualitative differences in reading, and phonological skills, between children with dyslexia and children with more general learning problems led this kind of ‘discrepancy’ definition to fall from favour. The Rose Review stated that dyslexia can occur across the IQ range and that poor decoding skills require the same kinds of intervention irrespective of IQ. In this paper, we argue that loosening the criteria for dyslexia has influenced common understanding of the condition and led to diagnostic confusion. In the longer term, the use of the term may need to change. Implications for research and practice are discussed.

### KEYWORDS

Dyslexia; reading disorder; reading difficulties; history; definition

A central theme in the history of dyslexia is the tension between the specificity of the disorder and its complex association with other forms of learning disability. Since its earliest description over 100 years ago, through the case files of the Word Blindness Centre (Whyte, [this issue](#)) and of Tim Miles (Evans, [this issue](#)) to more recent neuropsychological case studies (e.g. JM; Snowling & Hulme, 1989) is the notion that dyslexia is specific – a particular problem with reading and spelling that is somehow unexpected and therefore requiring a diagnosis and an explanation, as well as specialist intervention. At the same time, the history of dyslexia captures a sense of complexity that there might be ‘several “species” of dyslexia’ and it reflects a ‘family of disabilities’. These tensions play out in perennial discussions surrounding the definition of dyslexia, whether there are different ‘subtypes’ and questions about whether it even exists. In this article, we argue that loosening the criteria for dyslexia means that a far wider range of individuals now receive the label; furthermore, by understanding the co-occurrence of dyslexia with other disorders, we reach a better understanding of the heterogeneity of its manifestations.

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## Dyslexia – the discrepancy definition

For many years, research on dyslexia proceeded on the basis that it was a specific learning difficulty. The term ‘specific’ here referred to the fact that children with dyslexia have difficulties in the domain of reading (and spelling) that are ‘out of line’ with expectation, given age and IQ. Educational and clinical psychology practice was to look for a discrepancy between expected and actual reading attainment in order to ‘diagnose’ dyslexia. However, the failure to find qualitative differences in reading (and the phonological skills that underpin it) between children with dyslexia and children with more general learning problems led this kind of ‘discrepancy’ definition to lose credibility. To understand the implications of moving away from a discrepancy-based definition, we begin by reviewing how such a definition was operationalised and the evidence against its validity.

Originally conceived of as a measure of General Cognitive Ability or ‘g’, an individual’s IQ is simply their score on an IQ test. The most widely used measures of IQ are the Wechsler Scales which can be used to assess preschoolers, children and adults (e.g. Wechsler, 1974). For present purposes, it is important to note that these scales separate tests tapping verbal skills from tests tapping non-verbal or performance skills (though the division is not clean). The verbal tests include measures of vocabulary, verbal concepts, knowledge of the world and mental arithmetic. The performance tests primarily require practical responses, such as putting blocks together to make a pattern, or pieces of a puzzle to make an object; unlike the verbal tests, they are timed and hence tap speed of processing. An individual who has taken an IQ test typically obtains a Verbal IQ, Performance IQ and a Full-Scale IQ combining across both. Assuming no obvious neurological or sensory impairment and no lack of educational opportunity, children with average or above average Full-Scale IQ who nevertheless show problems with reading and spelling may be classified as dyslexic. This category corresponds to ‘Specific Dyslexia’, as used in the context of the Word Blind Centre (Naidoo, 1972). Dropping the discrepancy definition broadens this category.

One of the early critics of the discrepancy definition of dyslexia was Stanovich (1991). There were two main tenets of Stanovich’s argument against this approach. First, learning to read has a positive effect on verbal skills and vocabulary. Children who are good at reading read more and therefore have a greater opportunity to learn new information via print than children who are poor at reading. The corollary of this is a ‘Matthew effect’: the verbal skills of children who read less fail to keep pace with their peers (Stanovich, 1986). On this view, lower Verbal IQ (and, by extension, Full-scale IQ too) can be a consequence of poor reading and therefore the use of an IQ-based ‘discrepancy’ formula to differentiate different groups of readers is flawed. Second, Stanovich and Siegel (1994) showed that irrespective of IQ, poor readers experience the same core phonological difficulties (problems in dealing with the speech sounds of words). Given that reading skills show a continuous distribution in the population and that there are no clear qualitative or quantitative differences in reading as a function of discrepancy, effectively this means using the term ‘dyslexia’ for any cases of poor reading. While defensible on statistical grounds, to regard dyslexia ‘just’ as poor reading (and spelling) fails to capture the fact that it has an early onset (in preschool) and is persistent over time.

In an attempt to reconcile these views, the Diagnostic and Statistical Manual of the American Psychiatric Association (American Psychiatric Association, 2013) uses the term 'Specific Learning Disorder with impairment in reading' to describe what others, and lobbyists in particular, call dyslexia. The DSM5 definition notes that the term refers to 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' (p. 66). It also notes that a good indicator is 'low academic achievement for age or average achievement that is sustainable only by extraordinarily high levels of effort or support' (p. 69).

In summary, dropping the IQ-discrepancy definition of dyslexia has proven controversial for many, particularly for those who see 'dyslexia' as a special category of disorder and reject the view that it is only a reflection of poor reading. We will argue here that it is important to have a better understanding of the dimensionality of reading disorders and how they frequently occur with other difficulties.

### **Putting learning into the definition of dyslexia and the phonological deficit hypothesis**

Although intellectual disability precludes a diagnosis of specific learning disorder, once the practice of restricting the diagnosis of dyslexia to those principally with above-average IQ is abandoned, the kinds of learning difficulties to which the label 'dyslexia' applies widen and now include children with a broader range of learning problems. Such children have a range of problems with reading which are not best characterised as affecting only accuracy and fluency. A more principled approach then is to first consider the demands of learning to read and then consider how specific aspects of learning are affected in different 'types' of poor reader.

At the core of dyslexia is a difficulty in *learning* to decode and to spell. It is important therefore that our understanding of dyslexia is cast within a framework of learning to read. Reading development is a complex process (for a review see Castles et al., 2018). In simple terms, learning to read starts with learning mappings between print and sound. In alphabetic languages, the mappings are at a fine-grain between phonemes (the smallest units of speech) and graphemes (letter and letter groups), and in English there are many inconsistencies in the mappings, making learning to read difficult. As children grasp this alphabetic principle, they can translate print into sound and from that access the meaning of familiar words. This decoding process provides a mechanism for acquiring detailed orthographic knowledge about how written language works. Over time, and with reading experience, reliance on overt decoding declines as word recognition becomes increasingly efficient and automatised, allowing children to go from print to meaning rapidly and effortlessly.

More formally, we can consider reading development within the context of the influential 'triangle model', a computational model devised by Seidenberg and McClelland (1989). The triangle model comprises three sets of representations (phonological, orthographic and semantic) that interact and connect together to constitute the word recognition system.

Well before learning to read, children have well-developed phonological knowledge (of the sounds of words) that has connections with their semantic system (the meaning of words). Faced with written words, children need to form mappings from orthography to phonology and thus to meaning. Semantic knowledge can also support the development

of word reading, providing the means to adjust a partial decoding attempt (such as reading school as 's-chule') and bring it in line with a known word. Reading experience allows orthographic representations to become structured and for the whole system to embody the statistical regularities that exist between print and sound, and print and meaning.

In dyslexia, children are slow to learn to decode words and become fluent; they also struggle to generalise, that is, to read novel words they have never seen before. It is well established that in cognitive terms, dyslexia is caused by problems at the level of phonological representation (e.g. Shankweiler et al., 1979; Snowling & Hulme, 1994). This hypothesis has its roots in long-standing clinical observations, arguably starting with Orton (1937) and continuing with Bannatyne (1974), who noted difficulties in 'auditory sequencing, auditory discrimination, and associating auditory symbols with sequences of visual symbols'. A considerable body of research has since detailed the nature of 'auditory' problems in dyslexia, narrowing the deficit to one affecting the sound (phonological) structure of speech (Griffiths & Snowling, 2001; Vellutino et al., 2004): problems with phonology lead to difficulty in learning mappings between orthography and phonology and other difficulties which include problems learning new spoken words, poor verbal short-term memory and problems with word retrieval and picture naming (see Snowling, 2019 for review). Although learning to read has a reciprocal influence on phonological skills (Morais & Kolinsky, 2005), there is good evidence that phonological deficits in dyslexia are present in the preschool years, long before reading instruction begins (Snowling, Nash et al., 2019). Moreover, training phonological skills and letter knowledge improves reading ability, strengthening the claim that phonological skills are causally related to reading development (Hulme et al., 2012).

Nonetheless, despite the strength of the phonological deficit hypothesis, it seems that phonological difficulties are neither necessary nor sufficient to account for dyslexia (Pennington, 2006). While poor phonology is the impairment most consistently associated with dyslexia, many children at family risk of dyslexia who do not succumb to reading difficulties also have problems with phonological awareness (Snowling & Melby-Lervåg, 2016) and many individuals with dyslexia have deficits outside of the phonological domain (Saksida et al., 2016; White et al., 2006). According to the influential theory by Pennington (2006), dyslexia is the outcome of multiple risks which accumulate towards a threshold for what is usually termed 'diagnosis'. What are these additional risks and how can they be conceptualised?

To consider these questions, we can begin by looking within the reading system itself. While learning to read depends initially on learning mappings between orthography and phonology, other factors are also important. Semantic knowledge adds another source of variation: children with low language show relative weaknesses in learning to read words, especially evident for those words that are difficult to decode (Nation & Snowling, 1998). More generally, longitudinal studies show that preschool variations in oral language are associated with word reading ability in 8–9 year-olds (Hulme et al., 2015). Other research has focussed more directly on the learning mechanisms involved and asked whether the reading difficulties seen in dyslexia are associated with differences in paired-associate learning or statistical learning (see Nation & Mak, 2019 for a review). In addition, some children have been shown to have particular difficulty with letter position coding, making errors when dealing with words where precision is needed (e.g. *pirates* and *parties*; *smile*

and *slime*; Kohnen et al., 2012). Together these findings indicate that an individual child's score on a standardised test of word reading reflects multiple sources of variation (and difficulty). As computational models make clear, dyslexia is characterised by heterogeneity and individual differences (Harm & Seidenberg, 1999; Perry et al., 2019). However, to understand dyslexia fully we need to look beyond the details of the reading system itself and ask how additional factors influence reading and its development.

In summary, some of the complexity associated with dyslexia arises because the predominant proximal cause – a phonological deficit – is often not the only deficit that is observed. Moreover, phonological skills are themselves dimensional and can affect one or more aspects of reading. In particular, if the phonological difficulties occur as a 'downstream' effect of earlier language problems then reading comprehension as well as word decoding will be significantly affected.

### Comorbidities of dyslexia

Comorbidity refers to the co-occurrence between two (or more) disorders in the same individual. Comorbidity can be found between disorders within the same diagnostic grouping, e.g. reading disorder and mathematics disorder (both learning disorders with shared risk factors) as well as between disorders from different diagnostic groupings, such as between reading disorder and behavioural and emotional disorders (Angold et al., 1999). Rates of comorbidity between reading disorder and other neurodevelopmental disorders vary widely but, on average, about 40% of the children with a reading disorder/dyslexia will have another disorder as well (Moll et al., 2020). Many children with dyslexia have oral language problems extending well beyond the phonological domain. This was recognised by the Invalid Child's Aid Association in setting up the Word Blind Centre (Whyte, [this issue](#)) and is highlighted by Maughan et al. (2020) drawing on data from the Isle of Wight studies in the 1960s. An inevitable consequence of removing the discrepancy definition is that more children with poor reading in the context of broader and more serious language difficulties will be labelled 'dyslexic'. Since reading for meaning draws on language skills, it follows that many poor readers also have poor reading comprehension skills. Thus, whereas in classic discrepancy-defined dyslexia, reading comprehension is only an issue insofar as poor decoding presents a bottleneck to the construction of meaning, this is not the case for children with dyslexia who have co-occurring language problems; these children have poor reading comprehension too (Bishop & Snowling, 2004).

Some children with dyslexia meet criteria for Developmental Language Disorder (DLD), a disorder characterised by persistent difficulties in expressive and/or receptive language (Bishop et al., 2017). While usually considered a communication disorder separate from learning disorders, DLD is a major risk factor for dyslexia. Indeed, McArthur et al. (2000) showed that among children with specific reading difficulties (dyslexia), some 40% had significant language impairments; on the other hand, children who enter school with DLD are at high risk of literacy difficulties (Bishop & Adams, 1990). In short, the boundaries of dyslexia are not clear-cut: it is not uncommon for children with dyslexia to have language problems and some children also meet clinical criteria for DLD (Catts et al., 2005; Snowling, Nash et al., 2019). These language problems are under-diagnosed but are likely to affect response to intervention (Adlof & Hogan, 2019).

DLD is not the only disorder that co-occurs with dyslexia. Dyslexia is also often comorbid with attentional and motor coordination problems (Gooch et al., 2014; Rochelle & Talcott, 2006). There is also an overlap between dyslexia and speech sound disorder (Pennington & Bishop, 2009), socio-emotional and behavioural disorders (Carroll et al., 2005) and internalising problems such as anxiety and depression (Francis et al., 2019). None of these comorbidities should be viewed as 'core' features of dyslexia, but they can complicate both its presentation and response to intervention (Rose, 2009). Importantly for the present discussion, following relaxation of the discrepancy definition and hence the IQ cut-off, the number of 'symptoms' co-occurring with dyslexia has increased.

Another disorder that is frequently comorbid with dyslexia is mathematics disorder (or dyscalculia). Like reading disorder, mathematics disorder is classified as a specific learning disorder in DSM5 (American Psychiatric Association, 2013); it is comorbid with dyslexia in between 30% and 70% of the cases (Landerl & Moll, 2010). Like reading, mathematics is also a complex skill with multiple components. The overlap with dyslexia is high because many aspects of mathematics depend on verbal skills, e.g. number knowledge, counting, retrieval of number facts and verbal problem solving (Göbel & Snowling, 2010; Moll et al., 2018). However, mathematics also involves non-verbal skills; these include the ability to estimate numerosity and to compare differing magnitudes (Malone et al., *in press*). Further, numeracy problems have been associated with poor visual-spatial skills, poor executive function and working memory deficits; such deficits are commonly features of the kinds of non-verbal learning difficulty associated with lower Performance IQ (Gillberg & Gillberg, 1989). We can think of IQ as a broad measure of many aspects of cognition (including language, spatial, and attentional skills). Statistically, if we insist that only children with average IQ can be diagnosed with dyslexia, this will make dyslexia appear to be a specific disorder (because children with language or attentional problems will tend on average to have lower than average IQs and so fail to be diagnosed as dyslexic).

In summary, we argue that cases of 'specific dyslexia' exist and they are most apparent when a strict discrepancy definition (reading poorer than expected for a child's age and IQ) is adopted. However, when it is dropped, a wider range of difficulties are observed among children with reading disorders. The clinical and educational reality is that for many children, poor reading sits within a constellation of difficulties each of which represents a dimension. As the history of dyslexia shows, these are far from newly recognised issues; they have dogged dyslexia since it was first identified in the 19<sup>th</sup> century (Kirby, *this issue*).

## **Dyslexia diagnosis and treatment**

A growing concern among educators is the increasing incidence of dyslexia in school and in higher education. Do the increasing rates of this learning disorder reflect increased awareness of the condition or do they reflect over-diagnosis, particularly among those with the financial means to seek private educational assessment? This is the nub of an argument that has surfaced in a variety of forms since the first cases of reading disorder were described (Kirby, 2019). One of the main criticisms of those who are concerned with labelling dyslexia as a categorical impairment is that there are no clear cut-off criteria behind the diagnosis (Elliott & Grigorenko, 2014). DSM5 (American Psychiatric Association, 2013) stipulates that the term should only be used if there is restricted progress in



learning (to read/spell) and no catch-up with peers despite extra help at home or school; there should also be a low academic achievement. While precise criteria are avoided given the dimensional nature of the disorder, the manual does suggest that achievement (e.g. in literacy or numeracy skills) more than 1.5 standard deviations below the mean (a standard score of 78) assures the greatest diagnostic certainty; it also goes on to assert various exclusionary criteria and continues to advocate the importance of clinical judgement.

Arguably, it is the issue of clinical judgement which lies behind the dyslexia debate – and yet for all clinical conditions including infections and diseases, clinical judgement needs to be exercised before treatment can be determined.<sup>1</sup> We should also emphasise that dimensional disorders are common in many other areas of medicine and psychology – there are no clear cut-offs for diagnosing hypertension, obesity or depression; but for each of these very real conditions there need to be clinical decisions made about when an individual needs treatment. The same is true for dyslexia. To avoid the issue of clinical judgement and poor reliability around diagnostic thresholds, some have advocated the use of ‘response to intervention’ as an approach to diagnosis (Fletcher & Vaughn, 2009). Such an approach undoubtedly makes sense – if a child responds to treatment positively and can catch up with peers, then the label of ‘dyslexia’ is not appropriate because the condition is not persistent. Such children might be regarded as ‘instructional causalities’ – not having been taught properly in the first place or having suffered a set-back, for example, because of a poor command of the language in the case of migration. However, implementation of the response-to-intervention approach has not borne the anticipated fruit; children who fail to respond to well-founded intervention are just as likely to be identified following a comprehensive assessment with objective standards for referral for intervention as after their poor response to intervention – so why wait? Moreover, the characteristics of ‘treatment resisters’ include the phonological deficits that characterise dyslexia (Al Otaiba et al., 2014; Vellutino et al., 2004).

So where does this leave the issue of diagnosis and more broadly the practice of labelling a child or adult as having dyslexia? First, we propose that the term dyslexia should not be used as a shorthand for ‘reading disorder’ but should be used to refer to a difficulty with decoding and spelling fluency which is evident from the early school years and persistent over time. Second, it 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. Third, if there are co-occurring features, these should be labelled as such but should not be considered core to the ‘diagnosis’. Finally, the diagnosis should be qualified as mild (fully compensated when appropriate arrangements are in place), moderate or severe; we hypothesise that those with ‘severe’ difficulties are often those with a range of comorbid conditions.

In a similar vein, Miciak et al. (2014) criticised approaches that focus on a range of features in order to ‘diagnose’ dyslexia. Rather, they suggest that assessments should focus on the defining symptoms of reading difficulties, the functional impairments and co-occurring conditions. Such clarity is important if the causes of dyslexia are to be properly understood and the concept is to be fully embraced in educational policy. Another issue that has concerned those who do not support the use of the term ‘dyslexia’ is the fact that the types of intervention that are known to be helpful do not differ from the interventions that are useful for other poor readers. This is, however, a simplistic view. Dyslexia does equate with poor decoding and word reading, and therefore to say it requires similar treatment to poor reading is a tautology. The most robust evidence for

the effectiveness of reading interventions comes from randomised trials (e.g. Connor et al., 2013; Hulme & Melby-Lervåg, 2015; Melby-Lervåg & Lervåg, 2014). To date, the evidence suggests that the most effective interventions for children with dyslexia are phonologically based, involving training in phoneme awareness and letter knowledge combined with structured reading practice (McArthur et al., 2012). These interventions tackle the decoding deficit in dyslexia directly. However, there is a dearth of evidence for the efficacy of interventions to improve spelling and writing fluency – future research must address these important questions as a matter of urgency. There is also a need for treatment plans to consider the comorbidities that are associated with dyslexia, particularly language problems, and to consider their impact on the developing reading system. If these are not addressed, then response to intervention is likely to be poor.

In summary, elaborate comprehensive assessments are not required to identify a child as in need of reading intervention. What needs to be recognised is that reading is a dimension that is correlated with other skills and co-occurring difficulties (comorbidities) need separate management.

### **Conclusions: when is dyslexia a disability?**

The term dyslexia can be properly used to describe children who experience problems learning to read and write; often when a basic level of reading and spelling ability is established, there are persisting problems with reading fluency. Dyslexia is a dimensional disorder, however, with no clear cut-off from poor reading. This does not mean it is not a handicap. If difficulties in learning and in developing fluency persist, then we would argue the term should be used, not least to signal the need for intervention. In addition, it should be recognised that assessment is needed to identify co-occurring problems; if present, these may require separate management, *but they do not define dyslexia*. The need to intervene is clear: children with poor reading are at elevated risk for a range of emotional and behavioural difficulties. Moreover, longer-term follow-up studies make clear that problems with literacy persist into adulthood, and are associated with lower levels of educational attainment, higher rates of unskilled employment, and often periods of unemployment (e.g. Maughan et al., [this issue](#)). At the same time, since some individuals with dyslexia can compensate for their difficulties, dyslexia need only be disabling if the individual remains unable to cope with the literacy demands of study or work even when appropriate arrangements are in place.

How dyslexia is recognised by the education system, and by society more generally, has changed over its history, and continues to evolve. Here we have aimed to clarify some of the consequences that have followed from dropping the IQ-discrepancy definition of dyslexia. While questions remain, how reading develops and how best to teach it are now well understood (Castles et al., 2018) and policy implications are clear (Seidenberg, 2017). Despite best efforts, some children will continue to find reading difficult. Optimal outcomes for these children require us to embrace the dimensional nature of dyslexia and its associated complexities; to fail to do so is negligent and arguably morally indefensible.

### **Note**

1. Michael Rutter, contribution of oral history to the Dyslexia Archive, 2019.



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Maggie has been awarded honorary doctorates from Goldsmiths London, University College London, Warwick and Bristol Universities for contributions to the science of reading and dyslexia.

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