

# Dyslexia

***Despite over 100 years of research, dyslexia continues to be controversial because of the failure to agree on a definition and underlying causes, as well as the funding implications. This article identifies evidence-based factors that influence the development of reading and may cause difficulties, and the areas of continuing controversy.***

The field of dyslexia is riddled with controversies, from assessment through funding via the very existence of what may be regarded as an inexact syndrome. However, to the dyslexic individual, the difficulties are very real, and spread beyond simple reading and writing difficulties in school. In order to understand the problems, it is necessary to identify the issues and related controversies.

## History

Berlin (1887), in his monograph 'Dyslexia Eine besondere Art der Wortblindheit', is accredited as the first to use the term dyslexia when referring to the acquired loss of reading ability, although 10 years earlier Kussmaul (1877) had proposed the term 'wordblindness' or 'caecitas verbalis' for an acquired loss of words, thus introducing the visual analogy. Dejerine (1892) deduced that lesions in the medial and inferior portions of the left occipital lobe could lead to acquired dyslexia, and that fibres connecting the occipital lobes were also significant. In the English language, it is widely accepted that the first case of dyslexia was noted by Pringle Morgan, a medical doctor, and appeared in the *British Medical Journal* in 1896. He continued to use the visual metaphor, referring to the specific learning difficulty he encountered as 'congenital word-blindness', while Hinshelwood (1917) defined word blindness as a pathological condition caused by a disorder of the visual centres of the brain, which produces difficulty in interpreting written language.

In his original report Pringle Morgan (1896) noted: **'He (Percy) has always been a bright and intelligent boy, quick at games, and in no way inferior to others of his age. His great difficulty has been – and is now – his ability to learn to read.'**

In doing so, Pringle Morgan was setting the pattern for the next 100 years of using an 'intelligence'/word reading ability discrepancy model to define dyslexia (word blindness). This model, using aptitude (as usually measured by intelligence tests) as a criterion, assumes cognitive differences between the two groups of poor readers – those with high aptitude and those with low aptitude. Such assumptions, until recently (e.g. British Psychological Society, 1999), became embedded in both the scientific research into dyslexia as well as the policies and legislation designed to protect the rights of the dyslexic individual.

## Definitions

One of the biggest problems facing those working in the field of dyslexia, whether they are researchers, medical practitioners or educators, is the failure to agree on a common definition. As Pennington (1986) noted the results are going to be directly affected by how the behavioural phenotype in question is defined. With no common definition, progress is, at best, slow.

There are several approaches to definitions that should be noted. These include:

1. Symptoms-based definitions, e.g. Health Council of the Netherlands, British Psychological Society
2. A problem that leads to literacy difficulties, e.g. British Dyslexia Association, National Institute of Child Health and Human Development
3. The 10th revision of the International Classification of Diseases (ICD-10) (World Health Organization, 2004).

Most of the recent major definitions have been developed out of that proposed by the Health Council of the Netherlands. After appropriate consultation, they produced a series of criteria that they would use to determine the acceptability of a definition of dyslexia (Gersons-Wolfensberger and Ruijsenaars, 1997). With these criteria in mind, the committee produced the following 'working definition':

**'Dyslexia is present when the automatization of word identification (reading) and/or spelling does not develop or does so very incompletely or with great difficulty.'**

In their explanation, the Health Council of the Netherlands suggested that the use of the term 'automatization' refers to the improvement of reading- and spelling-related cognitive processes to the point where they become automated. This definition is free from any constraints of the language or script involved, acknowledging that as some children may do very well at these skills, so others will do poorly. Thus, in principle, it could be adopted for other countries and cultures. This definition became the basis for that proposed by the British Psychological Society (British Psychological Society, 1999) and subsequently the National Institute of Child Health and Human Development (Lyon et al, 2003).

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The author suggests that it is this 'difficulty in the acquisition' (Smythe and Everatt, 2002) of these literacy skills that is the key, i.e. it is not the inability to do the task on a given day, but the failure to acquire the skills given adequate opportunity. This is particularly important with the multilingual individual who may appear to have acquired literacy skills, but has failure to be taught the underlying skills, namely phonics.

The above definition and its derivatives (e.g. British Psychological Society, 1999) provide a list of symptoms whose existence can be measured. Much debate exists over how they should be measured and what the cut-off criteria are, but at least there is a pointer for development of diagnostic tools.

Some alternative definitions suggest that dyslexia is a problem that leads to reading and writing difficulties. For example:

**'Dyslexia is a specific learning difficulty which mainly affects the development of literacy and language related skills.'** (British Dyslexia Association, 2009)

**'Dyslexia is a specific learning disability that is neurological in origin.'** (International Dyslexia Association; Lyon et al, 2003)

**'Dyslexia is a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling.'** (Rose, 2009)

Some go on to identify 'characteristics', the diversity of underlying problems means that there are no identified core underlying characteristics. The problem is that they talk about dyslexia being a difficulty whose major impact is on literacy, but do not say what dyslexia is, except that it is some form of learning problem. Since the definition (by definition) provides the characteristics that puts somebody in a given class or category, failure to provide that within the definition makes any form of diagnosis problematic. Furthermore, inclusion of terms such as 'is neurological in origin' is unhelpful since any individual difference, whether it is the result of nature or nurture, is 'neurological in origin'.

Thus, if one accepts that in order to prove a condition, all you need to do is to prove what is in the definition, then by using the first definition, all you need to do is measure the difficulty in the acquisition of accurate and fluent reading and writing skills. However, for the second it is necessary to first define 'learning difficulty', and then prove that whatever this learning difficulty may be, it affects reading and writing more than anything else.

The World Health Organization, through ICD-10, takes an alternative approach of referring to:

1. F81.0 Specific reading disorder – a specific and significant impairment in the development of reading skills
2. F81.1 Specific spelling disorder – a specific and significant impairment in the development of spelling skills.

There is no separate definition of dyslexia. It is unclear why they could consider them separate, since they have common underlying cognitive processes and their development is heavily inter-dependent (Frith, 1980).

### Underlying aetiology

In her analysis of the current understand of dyslexia, Frith (1999) mapped causal theories of dyslexia to biological, cognitive, behavioural and environmental influences, using the Morton-Frith structured approach (Morton and Frith, 1995). Environmental refers to the teaching and learning environment, while behavioural may be considered the literacy outcomes. Cognitive influences refer to underlying processes, and are more fully discussed in the assessment section.

There are many conflicting theories of dyslexia, such as cerebellar (Nicolson et al, 2001) and magnocellular hypotheses (Stein, 2001). Both refer to structural differences. Research has been attempting to identify the underlying cause of those structural differences through brain scans and genetic research.

Reduced processing capability and neural integration of letters and speech sounds have been identified using functional magnetic resonance imaging as a probable significant underlying cause of dyslexia in many cases, explaining up to 40% of the variance in reading performance (Blau et al, 2010). Areas implicated include the anterior superior temporal gyrus, planum temporale or Heschl sulcus, superior temporal sulcus and fusiform gyrus.

Beneventi et al (2010) used functional magnetic resonance imaging to investigate specific working memory deficit in dyslexic individuals. They found that dyslexic readers showed less activation in the left superior parietal lobule and the right inferior prefrontal gyrus than controls.

However, there is a significant problem with brain scans with respect to the dyslexic individual and their differences that is rarely acknowledged. This may be exemplified in the work of Aylward et al (2003) who after just 28 hours of intensive intervention were able to clearly show changes in a dyslexic cohort. Specifically, before the intervention study dyslexic children showed significantly reduced activation in the left middle frontal gyrus, right superior parietal, and fusiform or occipital region during the phoneme mapping task, but closely matched the controls after intervention. The significance is not in the precise test, but that after such a short period of intervention, differences were detectable in the functional magnetic resonance imaging study. Therefore, given the nature of choosing the dyslexic cohorts for these studies, one has to question the extent to which prior activities influence the results. In other words, are the differences detected a reflection of biological differences that characterize individuals with dyslexia or a consequence of specialist teaching?

## Genetics

The research into the genetic origins of dyslexia is, at best, of variable quality because of the nature of identification of the cohorts. Since dyslexia (and reading) involves multiple cognitive processes, it is clear that there cannot be one underlying difficulty, but instead a series of possible difficulties that are linked to key underlying cognitive difficulties. (NB Some theories suggest that there may be a single underlying cause that leads to structural difference that may influence several processes. However, the evidence for this is not clear and cannot, as yet, explain the diversity found within those with reading and writing difficulties.)

To date, nine chromosome loci have been linked to dyslexia. Of these, the importance of 1p34-p36 (DYX8), 2p (DYX3), 6p21.3 (DYX2) and 15q21 (DYX1) has been frequently replicated. There is less evidence for the relevance of 3p12-q12 (DYX5), 6q13-q16 (DYX4), 11p15 (DYX7), 18p11 (DYX6) and Xq27 (DYX9). (Petryshen and Pauls, 2009). Four of the genes – DYX1C1 (DYX1), KIAA0319 (DYX2), DCDC2 (DYX2) and ROBO1 (DYX5) – have been implicated in neuronal migration and guidance, suggesting the importance of early neurodevelopmental processes in reading development. Furthermore, Poelmans et al (2009) identified a further four possible areas (PCNT, DIP2A, S100B and PRMT2) on chromosome region 21q22.3.

The heritability influence has been confirmed through the Colorado Longitudinal Twin Study of Reading Disability. Results suggest that shared genetic influences accounted for 86% and 49% of the phenotypic correlations between the two assessments for twin pairs with and without reading difficulties respectively (Wadsworth et al, 2007).

## Other potential causes

It should be noted that while there is increasing evidence of the inherited nature of dyslexia there are some instances where the problems may not have been present at birth, for example, otitis media, a common problem in infants. This can inhibit hearing at a crucial developmental age, and may influence development of those phonological skills important in development of fluent and accurate reading and writing. However, clearly it will lead to reading and writing difficulties and is constitutional in origin.

## Prevalence

There is much debate about the prevalence of dyslexia, with argument suggesting that it is increasing because of the nature of learning (e.g. more television, less reading, changes to ways we teach), that there can be no dyslexia in a language such as Chinese (with its high visual content) or Hungarian (which has a perfect sound-to-letter correspondence). However, the fact that dyslexia is caused by a series of underlying cognitive difficulties,

each of which may vary by degree (rather than either/or), means that while the definition may provide both symptom and causal components, they do not prove the criteria. Some definitions (e.g. ICD-10 in the early 1990s) did attempt to provide a cut-off, typically as two standard deviations. However, this has been replaced by terms such as 'significantly below'. Therefore, in reality, the prevalence can be set by anybody. Currently the most commonly cited source in the UK is the British Dyslexia Association, who suggest that 10% of the population are dyslexic, and of those, 4% are severely dyslexic. However, there is no basis to these numbers (Miles, 1991).

However, as Snowling (2000) points out, statistically 2.28% of any given population will be two standard deviations or more below the mean in a normal distribution, and results from dyslexia-related studies that use discrepancy criteria seem to reflect this figure derived from statistical theory. That is, there is no 'step' from dyslexic to non-dyslexic commensurate with has or has not got malaria. Instead, it is for the research to decide 'what feels about right'. Thus Yule et al (1974) calculated that 3.1% of 10-year-olds on the Isle of Wight had a 'specific reading retardation', assessed by using a discrepancy between (the now discredited) IQ and reading accuracy as their criterion, compared to 6.3% in London. If reading comprehension is used, these figures rise to 3.6% and 9.3%, highlighting the impact of the choice of test used for identification. Rodgers (1983) reported a figure of 2.29% using a reading test purporting to be an improvement over those used by Yule et al.

The study by Shaywitz et al (1992) reported figures of 5.6% in the first grade, 7% in the third grade and 5.4% in the fifth grade using a criterion of 1.5 standard deviations from the norm. (From a statistical perspective 6.68% would be expected of a normal distribution.) In discussing the arbitrary nature of dyslexia, Shaywitz et al (1992) noted that:

**'Our findings indicate that dyslexia is not an all-or-nothing phenomenon, but like hypertension and obesity, occurs in varying degrees of severity. Although limitations on resources may necessitate the imposition of cut-off points for the provision of services, physicians must recognise that such cut-offs may have no biological validity.'**

There has been much speculation about the gender bias in dyslexia, with more boys than girls generally identified. Shaywitz et al (1990) suggested that the bias was a product of the referral process (i.e. boys were more likely to be disruptive, and therefore received attention). Siegel and Smythe (2005) highlight that if there were differences at the cognitive level, then they were not yet proved. However, a study by Hawke et al (2009) suggests that while the norms for boys and girls may be equal, the variance for boys is greater, and this may account for some of the gender bias found.

### Diagnosis of dyslexia

The solution to dyslexia is educational, not medical – there is no medical treatment. Therefore it may be argued that the diagnosis should be educational. Most would argue that the tests necessary to identify the difficulties and needs of the dyslexic individual are specialist cognitive tests best carried out by an educational psychologist, a clinical psychologist or a speech and language therapist. However, irrespective of who is performing the testing, it is the specific knowledge of dyslexia assessment rather than the qualification that will ensure appropriate results.

The testing protocol will include many cognitive tests including phonological manipulation tasks and working memory. It is widely accepted that one of the key tests is for non-word spelling, where unfamiliar words are presented. Generally these can only be spelt if the child has acquired the necessary underlying skills. (See Snowling (2000) for a fuller discussion.)

However, while many dyslexic individuals may be identified within the educational system, there are still many occasions when the medical doctor may be the first to identify the problems. For example, many children suffer raised levels of stress and anxiety as a direct result of their literacy problems (Miles and Varma, 1995), and this may manifest itself in many ways, from bed wetting to ‘phantom illnesses’, especially to escape tests.

Furthermore, few diagnosticians are prepared to provide an assessment of the multilingual dyslexic individual, usually because they confuse the need for a categorical assessment (dyslexic or not dyslexic) with a needs analysis, i.e. what can the individual with dyslexia do and what needs to be taught? The first may in some cases release funding, but the second will inform teaching practice. Because of this, it may be that nobody has identified the multilingual child with dyslexia before being seen by a medical practitioner for secondary conditions. It should be noted that in many cultures it is the secondary condition that is identified and treated (e.g. antisocial behaviour) and the identification of dyslexia as the underlying cause is often missed as a result of a lack of awareness in that culture (Place et al, 2000).

It should also be remembered that dyslexia has a genetic basis, and that at least one of the parents is at increased risk of being dyslexic. This should be taken into account, not only when explaining the issues, but also in understanding possible problems of the parents.

Co-occurrent overlap with other developmental disorders is also an important consideration (as covered by Kirby in a subsequent article in this series). The underlying cognitive difficulties that impact upon reading and writing will also manifest themselves in other conditions. For example, executive functioning problems that affect essay writing may also affect motor planning (Piek et al, 2000). For this reason, it is important to under-

stand the relationship between the cognitive functions, and how one obvious problem (e.g. severe developmental coordination difficulties) may also hide dyslexia. Those with hyperactivity may also be dyslexic (Wiśniewska et al, 2007), although the underlying cause may be less clear.

### Future directions and challenges

Unfortunately the biggest obstacle to progress in the field of dyslexia is the cottage industry that has grown up around the needs of the dyslexic individual. Until there is a refocus to concentrate on a social model that provides for all, the support will remain in the hands of the few who shout loudest.

The Salamanca Statement (United Nations Educational, Scientific and Cultural Organization, 1994) suggested that every child has unique characteristics, interests, abilities and learning needs. But 17 years later we are still not looking at all children. Only those who are particularly noticeable, thanks to informed teachers and parents, are being identified and supported. The signatories of the Salamanca Statement, which included most states of Europe, agreed in principle to provide assessment, teacher training and education designed to support the dyslexic individual (Györfi and Smythe, 2010). However, services are well short of this ideal. Only then will the dyslexic individual have the opportunity to fulfil their potential.

The internet offers a number of potential opportunities for dyslexia support, with opportunities for, at the very least, mass screening to provide some form of triage, as well as remote management and monitoring of services. Some argue that in order to make this effective there would have to be general agreement on the definition. However, this is only true if one was trying to provide a label. If the intention was a needs analysis, then the only agreement needed would be with respect to the assessment process. Furthermore, it is likely that online services will provide learning systems suitable for dyslexic individuals, as well as continuing professional development.

Finally, the medical professional will always have a role to play, not only in the short term as we wait for these widely-available systems to come online, but also because there are always many individuals who would rather hide their difficulties than openly accept that they are different. Until that happens, there will be many instances when the first person to identify the dyslexic individual may be the person who understands the cause of their stress, phantom illnesses, behavioural issues and other problems usually left to the doctor to diagnose. **[BJHM](#)**

*Conflict of interest: Professor I Smythe is a leading developer of online assessment tools.*

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## KEY POINTS

- Failure to agree on a good definition of dyslexia has hampered development of effective recognition and intervention.
- There is no dyslexia or reading gene, but a series of genes related to underlying cognitive difficulties that are used in the reading process.
- Despite increased awareness and understanding of dyslexia, it is a pattern of problems, particularly stress-related one (including school refusal and somatizing symptoms) that may lead to the doctor being the first to identify possible difficulties.