Dyslexia and Language: Disorder or Difference?

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What is 'dyslexia'?

Questions concerning the nature of dyslexia have framed research in the field of children's learning difficulties for many years[1]. Put simply, dyslexia is a difficulty in acquiring fluent reading and spelling. More formally it is a neurodevelopmental disorder, its onset is in the early years, and it is life-time persistent. However, dyslexia is controversial and it continues to be debated more than a century after it was first described. The reason is that there is no sharp distinction between dyslexia and not dyslexia. Unlike chicken pox, which has characteristic signs and symptoms, dyslexia is more like blood pressure. While blood pressure ranges from low to high with no clear cut-offs, we diagnose hypertension (high blood pressure) because, if untreated, it increases the risk of serious health issues.

Just like blood pressure, measures of reading are continuous - they vary from weak to proficient, and it is necessary to use an externally agreed criterion to create a category which we call dyslexia. What is problematic is to agree a cut-off - 'disability' is not absolute but context dependent. Many people with dyslexia have mild symptoms yet these can be disabling in occupations that demand high levels of literacy.

What does the history of dyslexia tell us?

Dyslexia was first described in Germany in the late 19th century and in Britain in 1896 when a general practitioner, Dr Pringle Morgan, first described 'Percy 'who was – in his words:

> "*a well-grown lad, aged 14 … 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 inability to learn to read. …. in spite of laborious and persistent training, he can only with difficulty spell out words of one syllable".*

Morgan proposed that Percy suffered from a condition he described as 'congenital word blindness' , an pursued during the Victorian era. A prominent figure was James Hinshelwood, a Glaswegian ophthalmologist. Although the focus of his work was on vision, he proposed that the cause of 'word blindness 'was a difficulty not in perception but in naming visual objects - an idea that was to re-emerge many years later.

Research on dyslexia continued for many years primarily led by medical specialists. An influential figure in the 1920s was Samual T Orton, an American neurologist who coined the term 'strephosymbolia 'to describe phenomena, such as letter reversals (b/d), frequently observed in dyslexia. His work is especially noteworthy because he drew attention to the familial nature of dyslexia and especially to the fact that not only reading and writing, but also sometimes speech and/or language skills appeared to be affected. Together with his wife, June, he established a treatment clinic and hired two talented educators, Gillingham and Stillman, who devised teaching methods that are the basis of those used today.

The Word Blind Centre

[1] Snowling, M.J. (2018) Dyslexia: A Very Short Introduction. Oxford OUP

By the 1960s, knowledge of dyslexia had advanced and professionals from different disciplines gathered at the Word Blind Centre in Coram Fields, London, opened by Princess Margaret.

The work of the Word Blind Centre established a firm footing for dyslexia both scientifically and pedagogically. It also spurned dyslexia organisations, many led by women. Prominent figures in the field included Sandyha Naidoo, a psychologist who was the second Director of the Centre and later became head of a school for children with language disorders, Marion Welchman who established the British Dyslexia Association, Maisie Holt and Beve Hornsby who founded and expanded the Barts Dyslexia Clinic, Margaret Newton, the Aston Clinic and Elaine Miles who with her husband Tim, established a centre in North Wales. A downside of these developments was that dyslexia became dubbed a 'middle class syndrome – 'it was only women of 'certain means' that could afford the time to lobby for services for children with reading difficulties. Sadly, it also afforded an easy means for policy makers to reject the concept of dyslexia. Indeed, when the Government asked Mary Warnock to chair an independent review of children's special educational needs, she was forbidden from using the term 'dyslexia 'and from taking evidence from 'dyslexia specialists[2]. '

Nevertheless, research and practice was continuing apace and by the close of the 1970s, Frank Vellutino published a landmark review of the causes of dyslexia. Influenced by burgeoning understanding of how children learn to read, this review dispelled the idea that poor reading was due to any form of visual defect and argued that dyslexia was a verbal processing deficit[3]. In short, if asked to memorize a string of letters, good readers would be better than poor readers not because they were unable to 'see the letters 'but because they could not name them – echoes of the proposal Hinshelwood had made some 60 years earlier.

Learning to read

To understand how verbal processing impairments can affect learning to read a visible (written) language it is important to consider what learning to read entails. In all languages, learning to read requires the development of mappings or connections between symbols and sounds – in English these are between letters and the small speech sounds in words – phonemes; in Chinese they are between characters and larger sound units. A vital prerequisite for learning to read is awareness of these sound units. Yet this presents a considerable challenge: for a child a 'farm 'is a place where animals live'– it is not a combination of three sounds /f/ /ar/ /m/. But that insight is critical to the child learning English if they are to grasp the alphabetic principle that is the basis of reading and spelling.

Children, and even adults with dyslexia find it particularly hard to reflect on the speech sounds in words – so they take much longer to develop fluent read than their peers with good phonological processing skills. Their difficulty is part of a larger problem retrieving and segmenting the speech components of words. The phonological processing difficulty explains some other issues that people with dyslexia face as well. Consequences include a poor verbal memory, a slow rate of naming, errors when repeating unfamiliar words and often problems in finding the right words – an expressive language difficulty. Further features of dyslexia are difficulties with. spelling and writing and, if reading remains effortful, difficulties in understanding text[4].

But what about other languages? The world's writing systems differ along many dimensions: the first is the transparency of the writing system (how regular it is) – Finnish is the most transparent of the alphabetic systems, English is the least. It is much harder to learn to read English than it is to learn to read in Spanish or Czech which embody fairly consistent letter-sound relationships[5].

The second dimension along which writing systems vary is the number of symbols in the language - its orthographic breadth. English has only 26 letter and some letter combinations such as 'sh' while other languages have extensive symbol systems, notably Chinese. Furthermore, the larger the symbol system the greater the visual complexity of the symbols. This is because, when there are more symbols in a writing system, the differences between symbols must be in fine details to make them distinct. It follows

[2] Kirby, P. & Snowling, M.J. (2021). Dyslexia: A History. McGill-Queens Press
[3] Vellutino FR (1979) Dyslexia: Research and Theory ..
[4] Snowling, M.J. & Hulme, C. (2022). Annual Research Review: Reading disorders revisited–the critical importance of oral language. *Journal of Child Psychology and Psychiatry*, *62*(5), 635-653.
doi.org/10.1111/jcpp.13324
[5] Caravolas, M., et al., (2012). Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological science*, *23*(6), 678-686.Catts et al 2023 doi.org/10.1177/0956797611434536

that the demands of learning to read differ across orthographies depending on both their transparency and the size of the symbol set[6]. Nonetheless, across all languages, poor reading is associated with phonological processing difficulties[7].

Brain basis of dyslexia

So far, we have argued that the causes of dyslexia are within the language processing system. However, what is known of its brain basis[8]? Much current evidence comes from studies that have imaged the brain during reading. These studies reveal a set of neural pathways that connect different regions of the brain– the so-called reading network (shown as circles in Figure 1).

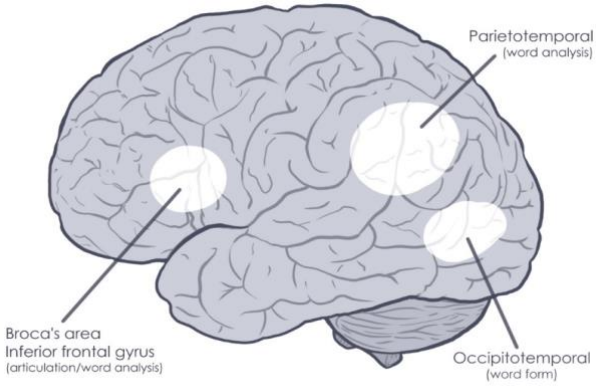

Figure 1. *The Reading Network*

The reading network extends across the left hemisphere, connecting the area which receives visual information (print) at the back of the brain via regions that are involved in language comprehension to the areas that subserve speech production. However, while it appears that these left hemisphere regions are under-activated in dyslexia, what is not clear is whether this difference in brain function is a cause or a consequence of poor reading.

Stronger evidence would come from studies showing that, before reading instruction, there are differences in brain structure and function in children at risk of dyslexia. An exciting line of research suggests structural differences in a pathway linking the back to the front of the brain (the arcuate fasciculus) predicts individual differences in the rate of reading development. However, these findings come from small-scale studies and need replication.

Genetics of dyslexia

It has been known for many years that dyslexia runs in families; in round figures, if a parent is dyslexic there is about a 50% probability that their offspring will be too. Hence there is a lot of interest in the genetic basis of dyslexia. However, families not only share genes but they also share environments. The study of twins is enlightening because, while twins typically share their environment, identical twins share all their genes, whereas non-identical twins share on average 50%. Since identical twins have been shown to be more similar in reading skills than non-identical twins, this provides good evidence that dyslexia has a genetic basis.

Molecular geneticists, taking the high heritability of dyslexia as a starting point, initially conducted association studies: such studies seek to find genetic differences between dyslexia-affected and typical

[6] Nag, S., & Snowling, M. J. (2012). Reading in an alphasyllabary: Implications for a language universal theory of learning to read. *Scientific Studies of Reading*, *16*(5), 404-423. doi.org/10.1080/10888438.2011.576352; McBride, C. (2015). *Children's literacy development: A cross-cultural perspective on learning to read and write*. Routledge.
[7] Catts, H. W., et al., (2024). Revisiting the definition of dyslexia. *Annals of Dyslexia*, 1-21. doi.org/10.1007/s11881-023-00295-3
[8] Yeatman, J. D. (2022). The neurobiology of literacy. In Snowling, MJ., Hulme, C. & Nation (Eds) *The Science of Reading: A Handbook*, 533-555.

reading individuals[9]. This early work led the discovery of 'gene markers 'on several chromosomes; the next step was to identify candidate genes on these chromosomes. Although enjoying some success, it soon became clear that single genes have very small effects and there are also complex gene-gene and gene-environment interactions. Furthermore, genes are 'generalists' and are involved in the etiology of more than one disorder. This discovery echoes the early proposal of Orton that families share disorders and is in line with clinical findings that developmental disorders tend to co-occur. In turn, it has led researchers to investigate how combinations of genes are associated with aspects of reading. This approach involves identifying gene variants associated with measures of reading behaviours in large samples of individuals and then summing these to give a polygenic risk score for every individual. While polygenic risk scores provide an indication of the risk of developing reading problems, very low correlations with reading mean they are not currently of use in the assessment or treatment of dyslexia.

Studies of children at risk of dyslexia

Although the genetic basis of dyslexia is complex, studies of children at family risk of dyslexia allow us to identify its precursors in the early years and afford the opportunity for early intervention.

In the Wellcome Language and Reading Study[10], we studied the development of children at family risk of dyslexia because they had an affected parent. We recruited the children when they were 3 ½ years old and assessed them every year until the age of 8 when we assessed their literacy outcomes. Since we know that phonological difficulties are at the core of dyslexia, and we know that phonological processing is part of the oral language system, we also recruited children whose language development was giving cause for concern. Children with no developmental concerns comprised a typically developing control group.

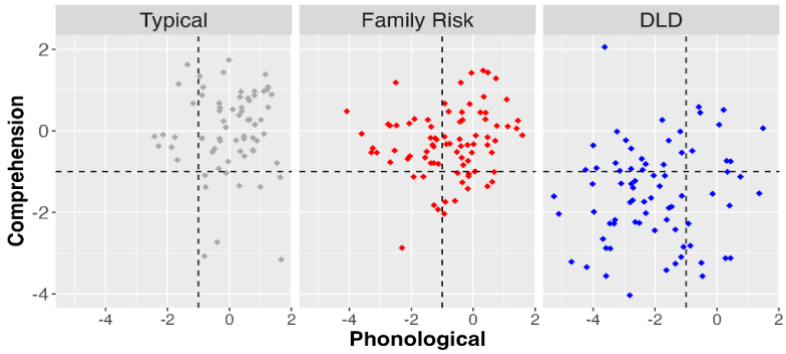

Figure 2: *Preschool Language Profiles for Children at Family Risk of Dyslexia (FR), at risk of Developmental Language Disorder (DLD) and controls (TD).*

Figure 2 shows the performance of the children in the Wellcome study in terms of their phonological skills (on the x-axis), and comprehension skills (on the y-axis). The first panel shows the typically developing group (TD), the middle panel, children at family risk of dyslexia (FR), the rightmost panel, children with preschool developmental language disorder (DLD). The cross bars indicate skills below average for age.

There is considerable variability among the children in the three groups. For the typical group, most points fall in the upper right quadrant indicating average phonological and language skills with only a few outliers. For the group at family risk of dyslexia, there are substantially more children with phonological difficulties, placing them at risk of problems learning to decode words. Similarly, the group with language concerns had phonological difficulties and they also experienced more general language problems.

Assessments of reading and spelling at age 8 were in line with predictions from these pre-school profiles. Defining 'dyslexia' as falling below age expectation on measures of reading and spelling, 7% of the typically developing group, 26% of children at family risk of dyslexia and 66% of the DLD group were iidentified as dyslexic. Thus, the risk was greatest for the DLD group who had both phonological and wider language difficulties.

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[9] Paraccini, S (2022) The genetics of dyslexia: learning from the past to shape the future. In Snowling, MJ., Hulme, C. & Nation (Eds) *The Science of Reading: A Handbook*, pp 491-514.

[10] Snowling, M. J., et al., (2019). Developmental outcomes for children at high risk of dyslexia and children with developmental language disorder. *Child development*, *90*(5), e548-e564

Examining our findings in another way, we can track the developmental pathways of children from the different outcome groups over time. This form of analysis highlights the fact that the children who are classified as 'dyslexic' 8 years-of-age show impairments of phoneme awareness and letter sound knowledge prior to school entry. Furthermore, children with persistent language difficulties - developmental language disorder – have even greater difficulty in acquiring these skills which are the foundation of the alphabetic principle. The findings provide a strong argument for the early identification of dyslexia, followed by intervention to prevent reading problems increasing.

Environmental influences on learning to read

So far, we have focused on two kinds of risk for dyslexia – biological and cognitive. But what about environmental factors? Genes act through the environment and brains respond to environmental input – what do we know about the role of the environment in learning to read?

We have already considered the differing demands of learning to read across different writing systems; there is preliminary evidence that in addition to phonological problems, children learning to read in complex orthographies need to rely more heavily on visual processing skills than do children learning in English. Visual deficits may present an additional risk for dyslexia among such children. Cultural differences also need to be taken account of – some cultures value literacy more than others and, in turn, this will be reflected in local educational policies and school curricula. In England, for example, a mandated curriculum of systematic synthetic phonics is believed to have raised literacy standards as evidenced by results from high-stakes testing.

At a more personal level, the home literacy environment has an important impact on learning to read, and arguably, the probability of developing dyslexia. Measures of the home literacy environment tend to focus on aspects of 'gene-environment' interaction. Passive influences include measures such as the number of books in the home and the amount of reading a parent does; active influences include whether the parent reads with the child or actively teaches them to read; finally evocative influences include the propensity of the child to seek out literary activities. In the Wellcome study we showed that the rate of shared book reading in the home was directly predicted by maternal language and literacy levels (and hence may have at least in part, a genetic underpinning), whereas active instruction appeared to be a matter of choice[11]. Both influences were important facilitators of reading development. It follows that there is merit in supporting home literacy, especially in families at risk of reading problems.

Finally, beyond the home, the child learning to read is susceptible to many other environmental factors not least in school; within schools, teachers' values and knowledge have a positive effect on children's attainments and this may be particularly so for children with special educational needs, such as dyslexia. Whether or not a child's reading difficulties are identified as 'dyslexia', and whether they are given appropriate support is likely one of the most important factors determining the longer-term outcomes of children with dyslexia – not only their literacy skills but also their adult well-being.

Do causes matter?

After many years of research investigating possible causes of dyslexia, it is reasonable to ask if causes matter. They do. An important reason is that they inform the design of theoretically motivated interventions. At the present time, the most robust interventions in the field of reading aim to address causes rather than just symptoms of poor reading. Failing to pay attention to causes can be a waste of resources and at worst, lead to 'miracle cures'.

Once an intervention has been designed, its efficacy should be assessed before it is delivered on a large scale. The gold standard for evaluating effectiveness is the randomized controlled trial, 'RCT 'for short. In an RCT, individuals are allocated at random either to receive some kind of treatment or not to receive it. The individuals in both groups are assessed on the construct of interest – say reading – before and after the treatment is delivered. Assuming groups are equated at pre-test (a legitimate assumption because the

[11] Puglisi et al., (2017) The home literacy environment is a correlate, but perhaps not a cause, of variations in children's language and literacy development. *Scientific Studies of Reading*, *21*(6), 498-514 doi.org/10.1080/10888438.2017.1346660

sample was divided at random), then a significantly better score on the measure at post-test for the group who received treatment shows that the intervention is effective[12].

Many treatments for dyslexia can be traced to those devised by Gillingham and Stillman - they are highly structured, systematic programmes that focuses on developing knowledge of the relationships between print (letters) and sounds (phonemes) for reading and writing. The approach is typically multisensory – using the child's strengths to reinforce areas of weakness. Generations of children have benefited from these approaches.

What works for dyslexia?

We have seen that the primary causes of dyslexia are in the domain of language and a core deficit is in phonological processing. It follows that interventions should aim to develop the phonological language skills that underpin reading. One such reading intervention is' Sound Linkage' , a 20-week reading intervention that combines training in phoneme awareness, in linking phonemes with letters for reading and writing, and reading practice from books. Sound Linkage is typically delivered to children with reading difficulties by trained teaching assistants in mainstream schools. At the core of the program are exercises to strengthen oral phoneme awareness and activities that train the links between phonemes and letters, moving on to sentence writing as the programme progresses. Importantly, this skill-based learning is reinforced through reading practice with texts at the instructional level that reinforce a phonic approach to reading as well as encouraging language-related skills and strategies for decoding words when a 'phonic ' approach fails (as it frequently does for children with dyslexia). Children receive daily sessions of the intervention outside of the main classroom, alternating between individual and small group sessions[13].

The evidence for the efficacy of this approach from RCTs is extensive - it improves reading and to a lesser extent spelling skills and its impact is durable[14]. However, as with any intervention, there are some children who fail to respond. Typically, such children have more severe phonological difficulties, often accompanied by co-occurring language weaknesses and sometimes attentional problems[15]. Such children require further assessment aimed at uncovering any additional weaknesses, and usually require more intensive, individualized support.

Why wait?

The science of dyslexia has flourished over the past 50 years, and we now know a great deal about the risk factors that predispose a child to poor reading: three are particularly important - a family risk of dyslexia, poor language at school entry and phonological processing difficulties. Given this evidence, professional practitioners are united in the view that there is no need to wait for an official 'diagnosis 'of dyslexia before intervening with a child who is 'at risk'. Moreover, given that language is the foundation of literacy, there is a strong argument for ensuring that these foundational skills are in place by the time of school entry.

With this in mind, we developed the Nuffield Early Language Intervention programme (NELI). This is a programme comprising training in oral language skills - speaking and listening, comprehension, vocabulary enrichment and narrative skills. NELI is a 20-week programme delivered by trained teaching assistants who have been trained to understand the structure of discourse and are provided with advice about strategies for encouraging children to improve their oral communication. NELI is delivered in daily sessions alternating between small group and one-to-one teaching; in the second 10 weeks of the programme, the language work is supplemented by training in phoneme awareness and letter-sound knowledge. Several research and

[12] Bishop DVMB & Thompson, PA (2023) *Evaluating what works*. Abingdon, CRC Press.
[13] Hatcher, P. J., et al.. (2006). Efficacy of small group reading intervention for beginning readers with reading-delay: A randomised controlled trial. *Journal of Child Psychology and Psychiatry*, *47*(8), 820-827 doi.org/10.1111/j.1469-7610.2005.01559.x
[14] Hatcher, P. J., Hulme, C., & Ellis, A. W. (1994). Ameliorating early reading failure by integrating the teaching of reading and phonological skills: The phonological linkage hypothesis. *Child development*, *65*(1), 41-57. **doi.org/10.1111/j.1467-8624.1994.tb00733.x**
[15] Duff, F. J., et al., (2008). Reading with vocabulary intervention: Evaluation of an instruction for children with poor response to reading intervention. *Journal of Research in Reading*, *31*(3), 319-336. **doi.org/10.1111/j.1467-9817.2008.00376.x**

larger scale RCTs have shown that the programme is effective for boosting language skills,[16] phoneme awareness, and letter knowledge, and although reading is not trained directly (reading instruction is delivered in mainstream), the programme has a small but significant effect on emergent reading skills[17]. Furthermore, there is some evidence that the improvement in language skills also boosts reading comprehension skills. NELI has been endorsed by policy makers and adopted by many primary schools as an effective approach for safeguarding the language and literacy skills of children in the Early Years of school. A neat example of a virtuous circle from research to practice.

Conclusions

Public awareness of dyslexia is widespread, and the science of reading is advanced. We also know how to intervene to improve children's reading and writing skills before they encounter significant difficulties which ultimately can be career-limiting. This is important not only for this generation of children but also for the next; if the downward spiral of poor reading, poor educational attainment and poor career prospects is not broken, then dyslexia will not only affect our children, and adolescents but have a downstream effect on the next generation, limiting their economic productivity and well-being.

But there is no quick fix - dyslexia and language disorder are life-time persistent difficulties. Challenges today may change tomorrow, and new forms of support may be necessary. However, it is vitally important to act now to ensure appropriate resources are directed towards assessment and interventions for children at risk of dyslexia.

[16] Snowling, M. J., et al. (2022). Delivering language intervention at scale: promises and pitfalls. *Journal of Research in Reading*, *45*(3), 342-366 **doi.org/10.1111/1467-9817.12391**

[17] West, G., et al.,. (2021). Early language screening and intervention can be delivered successfully at scale: evidence from a cluster randomized controlled trial. *Journal of Child Psychology and Psychiatry*, *62*(12), 1425-1434 **doi.org/10.1111/jcpp.13415**