

Chapter 2

Explaining Dyslexia

The Range of Research

There have been significant advances in research in dyslexia over the past 25 years. This has helped to provide explanations of dyslexia and these have resulted in new initiatives in policy and practice. It is still accepted that there is a range of different perspectives and research agendas.

Nevertheless the impact of the results of research has been far-reaching, and new tests, assessment procedures and teaching methodologies have resulted. Yet it can be argued that there is still no clear explanation that is universally accepted of what exactly constitutes dyslexia. It was for that reason that the contributors to DSM-5 opted not to use the term dyslexia but rather to opt for 'specific learning disorder' as an umbrella term.

There are new tests for dyslexia, and screening procedures are being refined and updated, yet identification of dyslexia is still riddled with controversies and uncertainties that can leave teachers and parents confused. There is still a debate, for example, on how IQ tests can inform a diagnosis—if at all (Siegel and Lipka, 2008). There is also an ongoing debate on the validity of dyslexia as an identifiable syndrome or whether it is a part of the continuum of reading difficulties (Elliott, 2007; Elliott and Grigorenko, 2014). Elliott suggests that 'The concept of dyslexia is now so broad that it encompasses so many things' (*The Times Higher Education*, 2014).

This chapter will discuss some of the main areas of research from Europe, the United States, Canada, the Middle East and Australia and New Zealand on dyslexia. This research indicates that dyslexia is a global concern and it is also an area where significant collaborative studies have taken place. Many of these have involved joint initiatives with researchers from different countries and continents working together. International organisations such as the International Dyslexia Association (www.interdys.org), the Learning Disabilities Association of America (LDA)

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(www.ldanatl.org), the BDA (www.bdadyslexia.org.uk), research organisations such as the International Academy for Research in Learning Disabilities (www.iarld.com) and reading researchers such as those from the Society for the Scientific Study of Reading SSS-R (www.triplesr.org) have all been instrumental in international collaborative initiatives.

Because of the complexities and the significant numbers of studies focusing on different aspects of dyslexia, it is useful to have a framework for understanding and discussing dyslexia. The causal modelling framework (Morton and Frith, 1995) is seen as a useful guide as it incorporates the neurological dimensions and the cognitive/learning dimensions as well as those related to practice—the educational dimensions—and these areas cover the research dimensions in dyslexia. Additionally, the framework takes into account the need to consider the environment and particularly how the environment can influence the other dimensions. This is particularly important as environmental influences (and cultural factors) are extremely important and can have as powerful an effect on learning outcomes as cognitive programmes and reading intervention.

Causal Modelling Framework

The three levels indicated by Frith can also provide a useful guide as the framework incorporates the perspectives of a range of professionals, and each group is likely to have different priorities and interests. For example, the teacher and the psychologist will be interested in the behavioural and cognitive dimensions, while the neurologist/psychologist will be interested in the neurological and biological factors. Frith (2002) states that ‘the important point is that at all three levels interactions with cultural influences occur’. It is important to consider this additional element to the framework as cultural and environmental factors are influential in today’s society and these factors will be discussed elsewhere in this book.

Causal Modelling Framework: An Explanation

Frith (2002) suggests that a causal modelling framework involving three levels of description—behavioural, cognitive and biological—can help to clarify some of the issues relating to the concept of dyslexia. Frith (2002) suggests that dyslexia is a neuro-developmental disorder with a ‘biological origin and behavioural signs which extend far beyond problems with written language’ (p.45). The discussion of the research in the remainder of this chapter will broadly follow the causal modelling framework, but it needs to be appreciated that one of Frith’s points about the framework is that it should be seen as being fluid and flexible and incorporating overlapping dimensions. This means that some aspects such as phonological processing can have an impact on all three dimensions—neurological, cognitive and educational.

Genetic Factors

A considerable amount of research activity has focused on the genetic basis of dyslexia. Gilger et al. (1991) estimate that the risk of a boy being dyslexic if he has a dyslexic father is about 40%. Much of this work has been focused on the heritability of reading sub-skills and particularly the phonological component. Gilger indicates the complexity of utilising and relying on data derived from genetic studies. This can be seen from the following list of genetic regions, which Gilger suggests are implicated in some way in dyslexia: 1p36, 2p16-p15, 2p11, 6p22.2, 7q32, 11p15.5, 15q21, 13, 16 and 2q. He also suggests that these regions could be responsible for different aspects of the reading and writing process such as: reading and verbal ability, single-word reading, spelling, phoneme awareness, phonological decoding, pseudo as well as non-word reading and writing, IQ, language skills, rapid naming and verbal short-term memory.

As can be seen from the above, there are a significant number of factors and studies identifying different areas of the genotype and relating them to different aspects of reading and literacy (the phenotype). Gilger (2008) acknowledges that this broad perspective of the impact of genes on learning and literacy needs to be accounted for and one needs to be wary of studies that make sweeping generalisations based on genetic evidence.

Nevertheless there is strong evidence that genes do have an impact on dyslexia and there will be children who are genetically at risk of dyslexia. This point is important as this can provide pointers for early identification.

Many of the gene studies do indicate the presence of a possible site for 'dyslexic genes': many of these are found in Chromosome 6. Significantly, they may be in the same region as the genes implicated in autoimmune diseases that have been reported to show a high level of association with dyslexia (Snowling, 2000). In a longitudinal study, Gallagher et al. (2000) found more than half the at-risk group of children aged 6 scored below average compared with a control group on literacy tasks. Castles et al. (1999) found a strong heritability element among 'phonological dyslexics'; and Olson et al. (1994, 2006) also found a strong heritability component for both phonological decoding and orthographic skills. Familial risk is therefore a useful indicator of dyslexia and is supported by prevalence rates (Molfese et al., 2008). The above indicates some of the advances in the field of genetics research which highlight the search for the underlying genetic basis of dyslexia. Additionally Scerri et al. (2010) suggest that *MC5R*, *DYM* and *NEDD4L* could make attractive candidates for dyslexia susceptibility genes, but they appreciate that further replication and functional studies are required. This work has been pursued in a large-scale European study (Becker et al., 2014), which investigated the candidate genes that have been implicated in dyslexia, including *DYX1C1*, *DCDC2*, *KIAA0319* and the *MRPL19/C2ORF3* locus. Although they observed association signals in samples from single countries, they did not find any marker or haplotype that was significantly associated with either case-control status or quantitative measurements of word reading or spelling in the meta-analysis of all the eight countries combined.

Neurobiological Factors

The advances in magnetic resonance imaging (MRI) and other forms of brain imagery such as positron emission tomography (PET) mean that, increasingly, they are being used to observe the active processes within the brain as well as brain structure. These have been of great benefit to neuroscientists investigating factors relating to dyslexia. From these studies a number of different factors have emerged focusing on structural and functional brain-related factors. Some of these are discussed below.

Visual and Temporal Processing

Singleton (2009) reports on the concept of visual stress and shows how it can interfere with the ability to read. It can also affect the development of fluent decoding of text and good reading comprehension. He argues that if visual stress is not identified and dealt with early on, children are at risk of remaining unskilled readers, particularly when trying to understand longer and more complex texts. The most widely supported theory of visual stress is that it is the result of a general over-excitation of the visual cortex due to hypersensitivity to contrast or pattern glare. Wilkins' theory (2003) is that the visual cortex functions normally until strong physiological stimulation results in stimulation of neurons that are close together. These neurons share inhibitory neurons and hence normal inhibitory processes will be compromised if they all fire together because the availability of inhibitory neurotransmitter is reduced. The outcome is the triggering of other neurons that signal movement or colours, which are consequently experienced as illusions or hallucinations.

Whiteley and Smith (2001) estimated the prevalence of visual stress in dyslexics to be in the region of 50%. Using ViSS, a computer-based screening tool for visual stress, Singleton and Henderson (2007) found that 41% of dyslexic children in their sample showed high susceptibility to visual stress; the corresponding figure for the non-dyslexic control group was 23%. White et al. (2006) found that 35% of their sample of dyslexic children aged 8–12 years met criteria for visual stress, while only 18% of the non-dyslexic control group matched for non-verbal IQ met criteria for visual stress. These findings raise an important issue on the relationships between dyslexia and visual stress.

Magnocellular Visual System

Singleton (2009) suggests the findings from research on the magnocellular visual system can also be related to visual stress. There are two types of cells found in the neural tracts between the retina and the visual cortex: *magnocells* are large cells that code information about contrast and movement; *parvocells* are smaller and code

information about detail and colour. (The magnocellular system is also sometimes known as the *transient system*, and the parvocellular system as the *sustained system*.) Cooperation between these two systems enables us to perceive a stationary image when we move our eyes across a scene or a page of text. When reading, the eyes do not move smoothly across the page but in a series of very quick jumps (saccades) in order to fixate successive portions of the text. During saccades, which typically take about 20–40 ms, vision is suppressed.

Stein (2008) provides evidence that the development of magnocellular neurons is impaired in children with dyslexia. Stein argues that the visual system provides the main input to both the lexical and the sub-lexical routes for reading and, therefore, the most important sense for reading is vision. One of the main discoveries about the visual system made over the past 25 years according to Stein is that the different qualities of visual targets are analysed, not one after the other in series, but by separate, parallel pathways that work simultaneously moving forwards in the visual brain. Stein shows that there are two main kinds of retinal ganglion cell, whose axons project all the visual information back to the brain. Ten per cent of these are known as magnocellular cells because they are noticeably larger than the others and cover an area 50 times greater than those of the much more numerous, but much smaller, parvocells. He therefore suggests that the great variety of visual, phonological, kinaesthetic, sequencing, memory and motor symptoms that are seen in different dyslexics may arise from differences in the particular magnocellular systems that are most affected by the particular mix that each individual dyslexic inherits. These factors discussed in relation to the magnocellular system and visual stress can have implications for practice. Stein (2002) has also highlighted convergence difficulties and binocular instability as factors that could affect the stability of visual stimuli when reading. In terms of intervention even simple procedures such as the use of coloured overlays can in some cases make a difference. For example, Kriss and Evans (2005) found that 45% of dyslexic children read 5% faster with an overlay, compared with 25% of non-dyslexic control children; when a more conservative criterion of 8% increase in reading speed with an overlay was applied, these figures dropped to 34% and 22%, respectively. Wilkins (1995) has also shown how some dyslexic children and adults may benefit from coloured overlays due to difficulties in some visual processes. Everatt (2002), in a comprehensive review of visual aspects relating to dyslexia, suggests that the visual representation processes, the magnocellular system, factors associated with visual sensitivity and coloured filters, and eye movement coordination can each account for the visual difficulties experienced by people with dyslexia. Everatt suggests that the diversity of the visual deficits that can be identified needs to be clarified as it may be that the visual-based difficulties derive from the same underlying cause. It should also be noted that not all those diagnosed as dyslexic present visual deficits, and indeed some people who are not dyslexic present evidence of visual deficits.

Furthermore, Stein's (2002) view on the role of the magnocellular system appears to implicate aspects of various complementary theories such as cerebellar immaturity

(Fawcett and Nicolson, 2001, 2008) and deficits in essential fatty acids (Richardson, 2002). In fact, fatty acid deficiencies have been linked to sleep problems (Richardson and Montgomery, 2005). Other visual intervention strategies are discussed in Chapter 13.

John Stein (Emeritus Professor of Physiology, Magdalen College, Oxford, <http://oxford.academia.edu/JohnStein>) has been instrumental in a number of breakthrough studies in nutrition, genetics and magnocellular research. An interesting recent finding has been the work on the integration of the visual and auditory pathways when learning to read. Harrar et al. (2014) assert that people with dyslexia can show difficulties in shifting their attention between modalities—‘sluggish attention shifting’ (SAS)—and this can appear when dyslexic people shift their attention from the visual to the auditory modality. Their results suggest that dyslexic people distribute their cross-modal attention resources differently from others, causing different patterns in multisensory responses compared with the control groups in the study. Harrar et al. therefore propose that dyslexia training programmes should take into account the asymmetrical shifts in cross-modal attention. This would mean that overlearning and consolidation in each of the modalities are necessary as the stimuli may not have been fully acquired.

Procedural Timing

The lateral zone of the cerebellum is an area that has generated interest owing to its apparent role in cognitive processes, and it has also been implicated in dyslexia (Fawcett and Nicolson, 2008). In terms of its formation, the cerebellum is one of the first brain structures to begin to differentiate, yet it is one of the last to achieve maturity, as the cellular organisation of the cerebellum continues to change for many months after birth. According to Fawcett and Nicolson (2008) there is now extensive evidence that the cerebellum is a brain structure particularly susceptible to insult in the case of premature birth, and that such insults can lead to a range of motor, language and cognitive problems subsequently. Fawcett and Nicolson (2008) argue that the cerebellar deficit hypothesis may provide a single coherent explanation for the three criterial difficulties in dyslexia—reading, writing and spelling. They argue this can place dyslexia research within a meaningful context in terms of the cognitive neuroscience of learning while maintaining its position as a key educational issue. They also suggest the cerebellar deficit hypothesis provides an explanation for the overlapping factors between dyslexia and the other developmental disorders.

One of the functions of the cerebellum is in the precise timing of procedures (e.g. several motor movements) that accomplish some sort of behavioural response or task performance. This timing of sequences may play a critical role in making task accomplishment or behavioural skills automatic. Indeed, a critical aspect of learning a skill may be to make its accomplishment automatic. This means that the skill can

be carried out without the individual giving it too much thought—and resources can be used to undertake other behaviours or processes simultaneously. For most adults and children, the ability to walk, talk and possibly read and write may be partially or completely automatic. Consequently Fawcett and Nicolson (2008) put forward the hypothesis that dyslexic children would have difficulty in automatising any skill (cognitive or motor). They suggest that reading is subject to automaticity and, since all dyslexia hypotheses predict poor reading as a factor in dyslexia, the automatization deficit hypothesis would be valid in relation to dyslexia. Fawcett (1989) and Fawcett and Nicolson (1992) argue there is clear support for this hypothesis stemming from a set of experiments in which they asked dyslexic children to do two things at once. If a skill is automatic, then the children should have been able to do two or more tasks at the same time. These findings strongly suggested that dyslexic children were not automatic, even at the fundamental skill of balance. For some reason, dyslexic children have difficulty automatising skills, and have therefore to concentrate harder to achieve normal levels of performance. This has clear implications for teaching and learning in that there will be a significant need for overlearning to be utilised with children with dyslexia in the classroom.

Hemispheric Symmetry

According to Geschwind and Galaburda (1985) the difficulties in processing information shown by people with dyslexia are due to structural differences between the hemispheres, and this likely develops in the prenatal period. This view has received considerable support from subsequent studies. Knight and Hynd (2002) are of the opinion that the principal findings to emerge from these studies suggest that misplaced cells may be present in some areas of the brain, particularly the outer layer of cortex, which is usually cell-free. According to Galaburda and Rosen (2001) and Galaburda (2014) these misplaced cells can be found predominantly in the left hemisphere in areas associated with language. They also note differences in the primary visual and auditory cortex, where differences in neurons and patterns of cellular symmetry can also be noted. This, they suggest, could provide a neural explanation for some of the visual, auditory, sensory and perceptual difficulties that some researchers, such as Fitch et al. (1997) and Zeffiro and Eden (2000), propose are associated with dyslexia.

Brunswick et al. (1999) reported that the PET scans of young dyslexic adults while reading aloud and during word and non-word recognition tasks showed less activation than controls in the left posterior temporal cortex. These findings suggest that there may be processing differences indicating some deficits in left hemisphere processing among children and adults with dyslexia. Paulesu et al. (1996, 2001) suggest that current theories of dyslexia favour a neuro-cognitive explanation. They suggest that at a neurological level, people with dyslexia may have microscopic cortical abnormalities in the form of cortical ectopias and dyslamination of cortical layers.

Reading is a complex activity that involves the interaction of multiple sensory systems and brain networks. Research findings such as those mentioned above can have implications for how the individual accesses print. The implications of this for teaching and learning to read have been the focus of the model proposed by Bakker (1979, 1990). Bakker (1990) and Robertson and Bakker (2002) called this model the 'balance model' of reading. It has been replicated in different countries (Robertson, 2000). Bakker identified different types of readers—'perceptual' and 'linguistic'—each with a different hemispheric preference, and each of these preferences has implications for teaching. The 'perceptual' reader has a right hemisphere processing style and may have good comprehension, but poor reading accuracy. On the other hand, the 'linguistic' reader utilises the left hemisphere and reads accurately, but in some cases may be over-reliant on the left hemisphere and may not show the comprehension level of the 'perceptual' reader. Wood (2000) suggests that reading is concerned with translating stimuli across all modalities and that fluency is the key factor in reading acquisition. He cites the role of the visual cortex in reading, which, he asserts, is multimodal as it will accept input from both auditory and visual modalities. The brain, he argues, is high in visual-spatial skills, and this also aids the understanding of information with high phonetic complexity. Since reading is essentially mapping across modalities according to Wood, then alternative languages such as music and visual graphics are helpful. In short, Wood suggests that our brains are better equipped for reading and more adaptable than we have given them credit for.

Processing Speed

Breznitz (2008) presents the 'Asynchrony Phenomenon' as a means to explain dyslexia. This implies that dyslexia is caused by a speed of processing gap within and between the various entities taking part in the word decoding process. Breznitz and colleagues devised a programme that attempted to train the brain to process information at a faster speed. Implementing this programme resulted in a substantial improvement among dyslexic children in the speed at which information was processed (Breznitz and Horowitz, 2007). They also suggested that this improvement was successfully transferred to other material not included in the training programme.

Breznitz (2008) also claims that dyslexic learners exhibit difficulties when transferring information from one hemisphere to another. These differences in inter-hemisphere transfer among dyslexics may stem from information decay in the corpus collosum, or a long non-symmetrical delay in inter-hemisphere transfer time. Shaul (2013) measured information transfer between the left and right hemispheres among dyslexics as compared to regular readers when performing various lexical decision tasks. She found that, among dyslexics, information arrived in the right hemisphere first, and was then transferred approximately 9–12 ms later to the left

hemisphere. Among regular readers, the information arrived in the left hemisphere first and was transferred to the right approximately 4–6 ms later. She also supported these results with source localisation of brain activity in these two reading groups during the word decoding process using low resolution electromagnetic tomography (LORETA). Comparisons between the groups revealed greater activation among dyslexic readers of between 110 and 140 ms for words, mainly in the right temporal and perisylvian regions, as well as some activation in the medial frontal regions. These findings could have significant implications for the classroom, particularly in how information is presented and the pace of lessons in class.

Phonological Processing

There is substantial evidence that the acquisition of phonological skills is crucial for successful reading and that difficulties in acquiring phonological skills are the cause of dyslexia. This perspective has been derived from the substantial evidence that difficulties in phonological processing, particularly when related to phonological decoding, have been a major distinguishing factor between dyslexics and non-dyslexics from early literacy learning to adulthood (Vellutino et al., 2004; Snowling, 2000; Bruck, 1993; Elbro et al., 1994; Rack et al., 1992) and that early phonological training (together with suitable linkage to orthography and literacy experience) improves word literacy and reduces the likelihood of literacy difficulties (Bryant and Bradley, 1985; Elbro et al., 1996). Children who find it difficult to distinguish sounds within verbally presented words would be predicted to have problems learning the alphabetic principle that letters represent sounds, and these would be the children who are most likely to be dyslexic based on the phonological deficit hypothesis.

Hagtvet (1997) and Lundberg (2002), in Norwegian studies, showed that a phonological deficit at age 6 was the strongest predictor of reading difficulties. Other studies have shown speech rate to be a strong predictor of dyslexic difficulties, and this is reflected in the development of the Phonological Abilities Test (Muter et al., 1997; Hatcher and Snowling, 2002).

Phonological Awareness and Multisensory Programmes

In educational settings there has been considerable activity in the study of phonological awareness in relation to dyslexia. This is reflected in the development of assessment and teaching materials such as the Phonological Abilities Test (Muter et al., 1997), the Phonological Assessment Battery (Fredrickson et al., 1997), the Dyslexia Screening Tests (Fawcett and Nicolson, 1996) and the Listening and Literacy Index (Weedon and Reid, 2001). Additionally, there are many phonological teaching approaches, such as Sound Linkage (Hatcher, 1994), the Phonological Aware-

ness Training Programme (Wilson, 1993), the Hickey Multisensory Teaching System (Combley, 2001) and the Multisensory Teaching System for Reading (Johnson et al., 1999).

Wise et al. (1999) conducted a large-scale study using different forms of 'remediation' and found that the actual type of phonological awareness training was less important than the need to embed that training within a well-structured and balanced approach to reading. Adams (1990a, 1990b) argues that phonological and 'whole language' approaches to reading should not be seen as incompatible. Indeed, it is now well accepted that poor readers rely on context more than good readers (Nation and Snowling, 1998). Language experience is therefore as vital to the dyslexic child as is a structured phonological awareness programme. This is particularly important in the secondary education sector, where it may be inappropriate to provide a phonological-based programme for a dyslexic student. Here the priority may be on language experience, print exposure and comprehension activities.

Everatt and Reid (2009) suggest the majority of evidence supports the view that a phonological-based intervention/teaching strategy will work for most children. However, alternative methods may be better for some, and a procedure for identifying who will benefit from what would be valuable. One way to do this is to monitor progress in the intervention and change the teaching method if the expected improvements are not occurring. Therefore, ongoing monitoring is important and, in the USA, initiatives such as Response to Intervention can provide sound pointers for this.

Morphological Processing

Deacon et al. (2008) argue that there is extensive evidence of morphological difficulties in dyslexic readers. They provide evidence from Leikin and Zur Hagit (2006), who argue that this interpretation is implicit in the research demonstrating two findings: a deficit in morphological awareness in dyslexics and a contribution of morphological awareness to reading that is independent of phonological awareness. Yet, they indicate that few, if any, researchers would explicitly argue that poor morphological awareness is a causal factor in the development of dyslexia. The probable line is that phonological difficulties are the primary deficit, and that these in turn cause both morphological and reading problems. Deacon et al. (2008) also suggest that central deficits, other than phonology, have been nominated as causes of both morphological and some forms of reading difficulties. They argue that one possibility is that dyslexics have deficits in morphological awareness due to general language delays since morphology is considered to be a sensitive indicator of language ability. They therefore indicate that, based on this point, the vast majority of current views indicate that morphological processing weakness is secondary to primary deficits in some other domain (e.g. general language skills or phonological processing).

It is important to appreciate the role of morphology in reading, as the use of morphological information may help to speed access to print. This has implications for

reading experience as morphological skills can come from greater reading experience. In fact Abu-Rabia et al.'s (2003) examination of the acquisition of Arabic orthography found that, following phonological awareness, morphological awareness was the most powerful predictor of reading ability. Similar results come from a study of English second-grade poor readers, for whom morphological awareness predicted reading comprehension beyond phonological and orthographic knowledge (Nagy et al., 2003). If phonological awareness is the source of both morphological awareness and reading difficulties for young poor readers, then it would be unlikely for morphological awareness to account for distinctive variance in reading. Deacon et al. suggest that one possibility is that dyslexics' difficulties with morphological processing (at least in comparison to chronological age matches) may originate in their more fundamental phonological difficulties. Yet, according to Deacon, phonological difficulties are unlikely to be the sole explanation of difficulties with morphological and reading tasks. The research suggests that the hypothesis that morphological awareness is independent, at least to some extent, of phonological abilities needs to be considered. Leikin and Zur Hagit (2006) articulated this when they noted that 'dyslexic readers are forced to resort to morphological decomposition for lexical access since their decoding abilities are not developed and processing the word as a whole is slow and inefficient' (p.486). Such differences can be viewed as an overreliance on morphological information in lexical access. This means that morphological processing might be a relative strength in comparison to a phonological weakness.

The implication of taking the role of morphological processing into account is that, if the phonological route is not successful, then literacy training at some point may need to rely more heavily upon other routes, such as the morphological route, to build up word recognition skills. The research conducted by Deacon et al. is important as teaching should integrate phonological and morphological instruction for children and adults with dyslexia. This is important to recognise as morphological processing is typically characterised as a late-emerging ability that builds on the core foundation of phonological knowledge (Ehri, 2005). It appears, therefore, that morphology may actually provide a compensatory avenue of instruction for dyslexics and, as Deacon et al. suggest, may be the means by which some individuals have overcome dyslexia.

Glue Ear

Peer (2005, 2016) has developed a strong argument emphasising the need to acknowledge glue ear syndrome as an influential causal factor in dyslexia. She cites evidence from Friel-Palti and Finitzo (1990) which suggests that hearing loss during the first 2 years of life may result in a delay in emerging receptive or expressive language or both. Additionally, Gravel and Wallace (1995) maintain that, although communication skills may appear normal for this group of children on entry to

school, other auditory-based deficits may emerge in the classroom situation. They and others suggest that there are weaknesses associated with listening comprehension, academic achievement and even attention and behavioural difficulties. Peer argues that ‘glue ear’ is an ongoing condition for large numbers of children, meaning that they experience significant hearing loss over a lengthy period of time. This may also lead to a lack of concentration as well as an inability to process the fine sounds that are necessary for auditory perception and speed of processing, which is a major key to language learning. Furthermore it does seem to be prevalent. When investigating numbers of children affected by repetitive bouts of the condition, Daly (1997) noted that, when investigating school-based incidence, the numbers are as follows: Japan, 4–15%; USA, 12%; Denmark, 16–22%; UK, 20–30%; Spain, 8%; Kuwait, 31%. These figures appear to be significantly higher than would be expected. Peer (2002) recorded that of 1000 people identified as dyslexic, 703 had experienced the condition to such a serious extent that they had undergone surgery. She also indicates that there appears to be a strong link with coexisting allergies, particularly to milk, highlighting a possible weakness in the autoimmune system. Some of the symptoms/characteristics identified by Peer (2009) are shown below.

Table 2.1 Symptoms/characteristics of glue ear

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- Early speech, language or communication difficulties
 - Confusion of letters and/or words especially when young
 - Mishearing words in speech
 - Difficulty in following a conversation/lesson/lecture when background noise is present
 - Difficulties learning additional languages
 - Spelling difficulties—omission of letters/sounds or phonetically spelled words
 - Reading weaknesses—single word, pseudoword, comprehension
 - Poor pragmatic language—children missing nuances of language, e.g. question mark
 - Poor written expression
 - Omission of words
 - Incomplete multisyllabic words or sentences
 - Confusion of tenses
 - Poor use and understanding of words, expressions and terminology
 - Delay in understanding subject-specific terminology
 - Weak general knowledge
 - Tiredness and weariness
 - Distractibility
 - Lack of concentration
 - Frustration
 - Feelings of insecurity
 - Difficulty following instructions
 - Social isolation and loneliness
 - Lack of understanding of playground rules
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Peer, 2009. Reproduced with permission of Routledge.

Peer suggests that glue ear can affect phonological processing and processing speed, and cause frustration when learning. She also suggests this can have considerable implications for bilingual learners. Peer strongly supports the view that there is a need to identify and provide for children experiencing dyslexic-type difficulties as early as possible if they are to make the greatest progress in their language and learning, and that the same is necessary for those who have experienced glue ear. It is important that proactive steps should be taken to prepare the child in the prerequisites for learning such as phonological skills, development of language and listening, and memory skills if glue ear is diagnosed or suspected.

Cognitive Skills

Dyslexia is essentially a difference in processing information (Reid, 2007), and cognitive factors such as memory and speed of processing difficulties are important at both the cognitive and the education levels. These can involve phonological processing, as noted above, memory, processing speed and other factors relating to learning. Wolf (1996; Wolf and O'Brien, 2001) highlights the 'double deficit' hypothesis, indicating that dyslexic people can have difficulties with both phonological processing and naming speed. It is interesting that speed of processing and semantic fluency are included in some of the popular tests for dyslexic children. Badian (1997) shows evidence for a triple deficit hypothesis implying that orthographic factors involving visual skills should also be considered.

Metacognition

The role of metacognition in learning is also of great importance as this relates to the learner's awareness of thinking and learning and can have considerable implications for how we understand the needs of children with dyslexia (Reid, 2001b). Tunmer and Chapman (1996) have shown how dyslexic children have poor metacognitive awareness and how this leads them to adopt inappropriate learning behaviours in reading and spelling. It is important, therefore, to examine the processes that the child uses in order to obtain a response. It may be that these processes or steps taken to complete the task are inefficient and ineffective. Chinn (2002) highlights this in relation to mathematics, and Wray (2002) in relation to creative writing.

Environmental Factors

The environment is an influential factor in learning. This implies that social and cultural factors can impact the outcomes of the learning experience. The environment

includes the learning context in the classroom, the school and the community, and this has an influence on both learning and teaching. It is important, therefore, to consider the individual learning styles and cultural preferences of the learner, as well as the policy and ethos of the school. These factors can help to provide a supportive environment that will have a profound influence on the outcome of the learning experience for students with dyslexia.

Additional Language Learning

It is recognised that dyslexic students often suffer from problems reading and writing in a foreign language (Sparks and Ganschow, 1993; Schneider and Crombie, 2006; Dal, 2008; Schneider, 2009). Dal (2008) suggests that one of the major breakthroughs in this field was undoubtedly the discovery of the necessity to relate and analyse the language the learners themselves develop and use during the process of learning. This language according to Dal is identified as the interlanguage. The idea of interlanguage is founded upon the assumption that a foreign language learner, at any particular moment in his or her learning sequence, is using a language system which is neither his or her first language, nor the foreign language. It is a third language, with its own grammar, its own lexicon and so on. The rules used by the learner are to be found in neither his or her mother tongue, nor in the target language. One can define the interlanguage as an emerging linguistic system that has been developed by a learner of a foreign language who has not yet become fully proficient but is only approximating the target language: preserving some features of his or her mother tongue in speaking or writing the target language and creating innovations. By recognising the interlanguage, both the research and the teaching of foreign language needs to focus more on the learner's needs and ability to communicate a message in the target language. Tal suggests that dyslexic students not only have problems learning grammar and how to write in a foreign language but they also experience severe difficulties with phonological coding—that is, converting symbols to sounds and sounds to symbols and forming a representation in memory. This is likely to have far-reaching effects on their foreign language learning and their ability to develop an active interlanguage. To help dyslexic students overcome their problems and to develop their interlanguage, Dal provides some areas of focus—these include the following:

1. phonological processing (poor grasp of sound, lack of awareness of individual sounds within words);
2. memory (working memory might be limited, there may be inaccurate representations in long-term memory);
3. auditory discrimination (uncertainty of the sound which has been heard, difficulty in discrimination between similar sounds, difficulty in knowing where a spoken word ends and a new word begins);

4. sequencing (getting things in order, e.g. letter order in words);
5. speed of processing information (tendency to be slower in responding to incoming information);
6. visual discrimination/recognition (poor ability to differentiate between similar-looking words).

In a multinational survey conducted in primary schools in Austria, Denmark and Iceland Dal et al. (2005) aimed to identify what schools could do to help dyslexic students participate in language classes, what language teachers do to help dyslexic students in language classes, what specific tools are used to help dyslexic students and what the language teachers see as the main problems of the dyslexic students learning a foreign language. The results of the survey indicate that, in general, the schools' policy is to include dyslexic students in foreign language lessons, but it was noteworthy that there was a huge variation within schools in each country and there was a discrepancy between the countries in the study. According to Dal the results suggest a need to make the problems of the dyslexic students in foreign language classes much more transparent in the official policy of the schools.

Dal suggests that the research indicates that the problems dyslexic students experience in learning a foreign language are closely related to written and oral skills in their mother tongue and that, although most language teachers and schools acknowledge that dyslexic students might have difficulties learning a foreign language, the policy of inclusion means that little special provision is made for them in language classes and many language teachers are unsure how best to teach them.

Dyslexia in Different Orthographies

Everatt and Elbeheri (2008) suggest that the manifestation of dyslexia may vary across different languages and, as such, is not language independent. Languages vary in the way their orthography represents phonology and, therefore, Everatt and Elbeheri claim that one of the main features which may determine the manifestation of dyslexia across languages is variability in orthography. In some orthographies, this relationship is relatively simple: there is close to a one-to-one correspondence between the written symbol (grapheme) and the basic sound (or phoneme) that it represents. In other orthographies, this correspondence is less transparent. A letter may represent several sounds, and a particular sound may be represented by different letters, depending on the context within which the letter or sound is presented. The English orthography is the best example of this less than transparent relationship between letters and sounds: there are many English words that may be considered irregular or exceptions based on the typically taught correspondence between graphemes and phonemes. German, in contrast, is relatively transparent for both reading and spelling (see discussions in Wimmer, 1993; Zeigler and Goswami, 2005). Although there are some exceptions (the length of vowel representations may require some

more complex rule learning, for example), once the relationships between basic written symbols and sounds have been learned, German written words should be pronounced with a good degree of accuracy. These cross-transparency differences pose a potential threat to the universality of the phonological deficit viewpoint. At the very least, in order to account for such findings, and retain phonological deficits as the main characteristic of dyslexia across languages, the phonological deficit hypothesis may have to incorporate more than phonological awareness weaknesses as a characteristic feature of the deficit.

More regular orthographies may require assessments of literacy skills that test speed of reading rather than accuracy, and measures of speed of reading may be better predicted by measures of speed of processing, such as rapid naming tasks, rather than measures of phonological awareness. Arabic orthography suggests that literacy learning difficulties may be best predicted on the basis of assessment procedures that include measures of phonological processing, including phonological awareness. They suggest that orthography transparency can be a useful predictor of variability across languages in literacy learning.

Bell and Tudhope (2016) argue that distinguishing between predicted second language difficulties and underlying specific learning challenges such as dyslexia is likely to be a complex task. They also suggest that, in order to offer focused and appropriate support and to encourage self-directed learning, it is important that both teachers and people with English as an additional language (EAL) and dyslexia understand their specific learning preferences.

This emphasises the importance of a full diagnostic assessment, which also needs to be underpinned by detailed background information that incorporates developmental, educational and cultural history.

Elbeheri and Everatt (2016), however, suggest that there is a lack of diagnostic tools that allow practitioners to distinguish between language differences related to the environmental context of growing up as a multilingual immigrant and language impairments of a neuro-linguistic origin.

Elbeheri and Everett (2016) suggest that one way of interpreting second language understanding problems is to assess the individual's first language. Measuring first language skills can be useful in order to distinguish between an underlying cognitive deficit and a lack of second language acquisition leading to poor vocabulary that may be improved simply by increased practice without having to make changes to teaching and learning.

If the language problem is evident in both first and second language measures, then an underlying deficit is most likely. On the other hand, if there is no evidence of difficulties with first language measures, then the second language weaknesses may be more to do with poor learning experiences. They acknowledge that further work will be needed to specify the likely cause in the latter case, but first language assessments should support this process of identifying cause.

Pascale et al. (2013) suggest that linguistic and cognitive assessments for language minority children require careful choice in relation to the measures selected in order to ensure valid results. Dyslexia assessment is a dynamic process that is

ultimately intended to help the person with dyslexia. This therefore goes beyond a diagnosis and focuses on intervention. But usually it is only following an appropriate assessment that an individual with dyslexia can obtain the help and support to which they are entitled. Elbeheri and Everett therefore strongly suggest that those conducting the assessment must do their best to 'get it right'. This means that in order to assess for dyslexia, the assessor must be knowledgeable of the likelihood of dyslexia manifestations in the context of the individual being assessed.

Self-disclosure in Adults

One important consideration is the self-awareness people with dyslexia have of dyslexia, and how this might impact them in education and in the workplace. One of the key indicators of the level of self-awareness can in fact be gleaned from studies on self-disclosure. Price and Gerber (2008) report on a number of studies in relation to self-disclosure and they themselves have developed a protocol to measure this and to identify reasons why students with dyslexia are reluctant to disclose the nature of their difficulties. Many of the studies in this area relate to adults. Roffman et al. (1994) assessed the effectiveness of a college course for greater disability awareness. They found that greater self-understanding led to willingness to disclose in social and employment settings. On the other hand, Lynch and Gussell (1996) explored disclosure and self-advocacy in post-secondary students with learning disabilities and found they feared stereotyping and attribution of unfounded characteristics associated with learning disabilities. Vogel and Adelman (2000) investigated former college students 8–15 years past graduation. They discovered that 41% chose not to disclose in the job, and if they did it was for the purpose of obtaining job accommodations. Self-disclosure is important because it is a very important element of self-determination. Often people with dyslexia have to be self-advocates and take a lead role in determining the outcomes of workplace accommodations.

Price and Gerber (2008) suggest the following factors should be considered in the self-disclosure:

- Self-disclosure is driven by context and situation.
- Self-disclosure is the management of personal information.
- Self-disclosure is nestled in the larger concept of self-determination.
- There is risk in self-disclosure.
- Disclosure 'protects' in some contexts.
- Disclosure must include information and not just the label.
- Disclosure is just the beginning.

As Price and Gerber suggest, self-disclosure 'is the "opening gambit" of a process housed under the umbrella of self-determination, but driven by very skilful

self-advocacy skills'. Research studies focusing on self-advocacy and self-disclosure are important additions to the literature on dyslexia because they directly relate to the individual.

Points for Reflection

- How useful is the research on dyslexia? How might it impact on your practice?
- Consider how the causal modelling framework can fit into your practice—to what extent can it offer an explanation for dyslexia that fits into both policy and practice?
- Given the wide range of areas that can be implicated in understanding dyslexia described in this chapter, consider the importance of perceiving dyslexia within a 'learning' paradigm rather than a 'literacy' one. How appealing is this broader view of dyslexia?
- How important would you consider the environment to be in both identification and intervention for dyslexia? Consider your own learning environment and how suitable it is for learners with dyslexia.
- Consider the importance of examining dyslexia in different orthographies.
- Self-disclosure is an important consideration—how might you help a young person with dyslexia achieve this? Consider how important it might be to spend some time focusing on this aspect.