Learning Disabilities: Research and Implications for Practice

Dr. Gavin Reid

gavinreid66@googlemail.com

Learning Disabilities has been described as a variable syndrome because of the spectrum of difficulties used to describe it and the variation of the characteristics. This is supported by the many different definitions of Learning Disabilities in existence (Vellutino, F.R., Fletcher, J.M., Snowling, M.J., & Scanlon, D.M. (2004). At least nine different hypotheses can be put forward to define learning disabilities: These include the following:

1. Phonological deficit hypothesis,
2. Temporal processing hypothesis,
3. Skill automatisation hypothesis,
4. Working memory hypothesis,
5. Visual processing hypothesis,
7. Intelligence and cognitive profiles hypothesis,
8. Learning opportunities hypothesis and
9. Emotional factors hypothesis.

These hypotheses refer to different or overlapping theoretical approaches to explain dyslexia.

It is suggested that the phonological deficit hypothesis provides the main focus because of the 'broad empirical support that it commands' and because of the impact of phonology on the other hypotheses, particularly temporal processing hypothesis and skill automatisation hypothesis.

This view is supported by Snowling (2000) who suggests that although Learning Disabilities (dyslexia) can manifest itself in many ways there may be a single cause—a phonological deficit—and she asserts this is the 'proximal cause of dyslexia' (p. 138).

Causal Modeling Framework

The different facets that make up Learning Disabilities can be understood more clearly by referring to the causal modeling framework (Morton and Frith 1995).

Frith (2002) suggests that the definition and explanation of Learning Disabilities has long been problematic and 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 LD.

Frith (2002) suggests that LD involve neuro-developmental disorders with a 'biological origin and behavioural signs which extend far beyond problems with written language' (p. 45).

The three levels suggested by Frith can provide a useful guide as different professionals will have different priorities and interests. The teacher and psychologist will be interested in the behavioural and cognitive dimensions while the neuropsychologist will be interested in the neurological and biological factors. The important point is that at all three levels interactions with cultural influences occur. Frith suggests that these influences have a major impact on the characteristics of Learning Disabilities displayed by the individual.

It is also important to consider a fourth element—environmental aspects—and to appreciate how this can affect children and adults with LD. It can be argued that the environment and the learning experience can influence the impact of Learning Disabilities on the individual.

It can be suggested that Learning Disabilities is contextual and therefore the nature and extent of the difficulties can vary depending on the context and the task. This means that it is feasible that adaptations to the learning and work environment, and particularly on how the task is presented and assessed, can make a significant difference to the outcome and the learning experience for the individual with LD.

The three levels

Biological level

- Genetic Factors

A considerable amount of research activity has focused on the genetic basis of dyslexia. Gilger et al. (1991, 2008) estimate that the risk of a son 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. Castles

et al. (1999) found a strong heritability element among ‘phonological dyslexics’, and Olson et al. (2006) also found a strong heritability component both for phonological decoding and orthographic skills. Gene markers for Learning Disabilities have been found in Chromosome 6 in a number of studies (Fisher et al., 1999). These studies indicate the presence of a possible site for ‘dyslexic genes’ in Chromosome 6, and 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 Learning Disabilities (Snowling,2000).

Brain Structure

Scanning techniques such as positron emission tomography (PET) and magnetic resonance imaging (MRI) are increasingly being used to observe the active processes within the brain as well as their structure. As a result, studies have shown that (e.g., in phonological and short-term memory tasks) people with Learning Disabilitieswould likely display less activation across the left hemisphere than one might find in people who do not have a dyslexic profile. 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 Learning Disabilitiesfavour a neuro-cognitive explanation. They suggest that at a neurological level people with Learning Disabilitiesmay have microscopic cortical abnormalities in the form of cortical ectopias and dyslamination of cortical layers.

They also suggest that there is considerable agreement that a causal link between brain abnormality and reading difficulties involves phonological processing deficits although the cause of these deficits is less clear. This also implies that these factors can be noted universally irrespective of the language used in the country although they do suggest that in languages with transparent or shallow orthography, such as Italian, learning to read is easier than in languages with deep orthography such as English and French, where they suggest the mapping between letters, speech sounds and whole word sounds is often ambiguous.

- **Magnocellur deficit**

Stein et al. (2001), Everatt (2002) and Eden et al. (1996), describe the 'magnocellular deficit hypothesis' in relation to Learning Disabilitiesas a consequence of an abnormality in the neural pathways of the visual system. This pathway is divided into two areas, the parvocellular (P) and magnocellular (M) systems. These are differentially sensitive to different types of stimuli; the parvocellular system seems to respond to slowly changing (low temporal frequency) information and to colour, whereas the magnocellular system is more sensitive to gross (lower spatial frequency), rapidly changing (high temporal frequency) or moving information. Stein et al. (2001) suggest that the dyslexic person records poor performances on tasks assessing the functioning of the magnocellular pathway. This therefore will have implications for reading and particularly the visual processing factors associated with reading.

In relation to Learning Disabilitiesand visual difficulties Stein et al, 2002) have also highlighted convergence difficulties and binocular instability as factors that could affect the stability of the visual stimuli when reading. Wilkins (1995) has 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 Learning Disabilitiessuggests that the visual representation processes, the magnocellular system, factors associated with visual sensitivity and coloured filters, and eye movement co-ordination 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) and deficits in essential fatty acids (Richardson, 2002).

- **Hemispheric differences**

According to Galaburda and Rosen (2001) there are 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), Zeffiro and Eden (2000), propose are associated with dyslexia.

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 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 two 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.

- **Motor Factors**

Motor integration programmes have also been developed from research programmes Nicolson and Fawcett (1999) have shown how cerebellar immaturity may be implicated with Learning Disabilitiesviewed from a broader framework and may be involved in acquiring language dexterity as well as movement and balance. Factors such as postural stability, beads-threading and naming speed are therefore represented in the Learning DisabilitiesEarly Screening Test (Fawcett and Nicolson, 1997). There have been many studies reporting on fine motor and gross motor difficulties experienced by dyslexic children.

Cognitive and Processing Dimensions

While the teacher may be limited in dealing with the deficits discussed above in relation to the neurological/biological factors associated with Learning

Disabilitiesmuch can be done to improve the processing skills of dyslexic students, and particularly their phonological skills. It is important that cognitive skills or deficits/delays are separated from observed behaviours (i.e., the characteristics of dyslexia), because these cognitive aspects can only be inferred. Nevertheless, cognitive factors such as memory and speed of processing difficulties can be noted by the class teacher in relation to the student's strategies and learning progress, and can have an impact on lesson plans and curricular progress. Some of the cognitive factors that can be influential in relation to Learning Disabilitiesare shown below.

- **Phonological Processing**

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.

Wolf (1996; Wolf and O'Brien 2001) highlight the 'double deficit' hypothesis indicating that dyslexic children can have difficulties with both phonological processing and naming speed. Badian (1997) highlights 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 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 Learning Disabilities(Burden, 2002; Reid, 2001).

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 used in order to obtain a response. It may be that these processes or steps taken to complete the task were inefficient and ineffective. Chinn (2002) highlights this in relation to mathematics and Wray (2002) in relation to creative writing.

- **Automaticity**

Similarly, difficulties in automaticity (Fawcett and Nicolson, 2008 Fawcett, 2002) implies that dyslexic children may not readily consolidate new learning and therefore find it difficult to change inappropriate learning habits. Fawcett and Nicolson in fact, propose the twin hypothesis that dyslexic children incur both dyslexic automatisation deficit and conscious compensation hypothesis. This means not only do they have difficulty in acquiring automaticity, but in many cases they are able to mask this deficit by working harder. Deficits, however, will still be noted in situations where compensation is not possible.

Behavioural level

Observations on performances in reading and spelling activities can be described at the behavioral level. These are the directly observed behaviors—the noted characteristics of dyslexia, such as words spelt incorrectly or words read inaccurately. It is important to consider that such observations will be influenced by a range of environmental factors, including the classroom environment and social and cultural aspects. Essentially the behavioral level relates to educational factors, and some of these will be discussed below.

- **Phonological Awareness and Multisensory Programmes**

In educational settings there has been considerable emphasis in phonological processing in relation to dyslexia. This is reflected in the development of assessment and teaching materials such as the the Phonological Assessment Battery (Fredrickson et al., 1997),the CTOPP (Torgeson, Wagner et al), The Listening and Literacy Index (LLI) (Weedon and Reid, 2001). Additionally, there are many phonological teaching approaches such as Orton Gillingham, Sound Linkage (Hatcher, 2004), the Hickey Multisensory Teaching System (Combley, 2001) and the Multisensory Teaching System for Reading (Johnston 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 (1990) argues that combining 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. It is also important to note the current interest and research in the area of multilingualism and Learning Disabilities(Peer and Reid, 2000; Cline and Shamsi, 2000), which indicates the need to obtain accurate measures of screening, identification and curriculum materials to ensure that the needs of multilingual dyslexic children are met within mainstream provision.

Right Hemisphere Processing

West (2004) has utilised Galaburda's research to show that dyslexic people who are right hemisphere processors can actually be at an advantage in some situations. This emphasises the positive side of dyslexia. Additionally, West suggests that the transmission of knowledge and understanding is increasingly becoming visual and that those with well-developed visual skills can be at an advantage in acquiring the visual language of knowledge. Furthermore, the work on multiple intelligences (Gardner, 1983, 1999) highlight how the strengths of students with Learning Disabilitiescan be utilized within the classroom and mainstream learning environment.

Environmental Factors

The environment is influential at all stages of the Morton and Frith model. The model is interactive, which means that all components of the model - neurological, cognitive and behavioral interact with and influence each other. This process is however very much mediated by the environment. The environment in this case is the social and cultural factors that the individual brings to the learning situation, but it means more than that. The environment includes the learning context in the classroom and the school. It is important therefore to consider the individual learning styles and preferences of the learner as well as the policy of the school, the school district and the training of staff. 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.

Comment

It is important to recognize that no one strategy, program or approach can stand in isolation - each has to be part of a bigger package, preferably a whole school package, that involves not only the whole child, but also the family, other professionals and the cultural aspects of the community. The field of Learning Disabilitiescan claim to have made considerable progress in the last decade. With a prevalence of around 4% in most countries, Learning Disabilitieshas a universal currency. There have also been significant advances in the theoretical understanding of dyslexia, and the causal modelling framework described in this paper helps to clarify the overlapping and complementary aspects of the theory and how these factors can relate to practice.

One of the significant factors has been the broadening of the conceptual understanding of Learning Disabilitieswithout in any way minimizing the nature and function of the label. Learning Disabilitiesis rightly viewed within a continuum and can overlap with other specific difficulties as they may share similar neurological, biological and cognitive mechanisms. Yet although the new theoretical developments raise a number of questions this should be viewed ‘as a strength rather than a weakness, reflecting the opening up of fruitful new research avenues’ which can impact on practice.

Factors associated with the Causal Modeling Framework for Dyslexia

Neurological/biological factors

- genetic factors
- cortical abnormalities
- magnocellular deficit hypothesis
- the role of the cerebellum
- dietary factors
- inhibition of primitive reflexes
- left hemisphere under stimulation
- convergence difficulties and binocular instability
- visual sensitivity and coloured filters and eye movement co-ordination

- hemispheric symmetry

Cognitive factors

- phonological processing
- naming speed
- working memory
- metacognitive factors
- automaticity

Behavioural factors

- pattern of errors in reading and spelling
- writing difficulties
- time management difficulties
- more time to complete work
- inaccuracies in copying
- avoidance of writing
- discrepancies in performances in curricular activities

Environmental/contextual factors

- learning environment
- learning styles
- education policy/legislation
- staff training
- social and cultural factors

Implications for Practice

The following are some of the key factors relating to Learning Disabilitiesstemming from one or more of the dimensions in the causal modeling framework.

- **Reading**

Decoding

This is a difficulty in accurately breaking down words into their constituent parts. For example the word governmental has to be broken down as follows *gov/ern/men/tal* in order to be decoded. Usually after a reader has seen this word a few times it can be read by sight. Children with Learning Disabilitiesmay have difficulty in breaking words down into their constituent parts and in transferring a word from a decoding strategy to a visual (sight word) strategy. Additionally Children with Learning Disabilitiesmay not have many sight words in their 'known' vocabulary. This means that almost every word, and certainly words that are not commonly used, will need to be decoded, ie broken down into their constituent sounds. This can be problematic for the child with dyslexia. In order to do this the reader needs to have some skills in phonemic awareness and be able to recognise the different sounds and groups of letters (syllables) that make up a word. This difficulty with breaking words down in syllables will affect reading fluency.

Children with Learning Disabilitiesmay also substitute words when reading aloud, for example saying 'car' for 'bus. '

Fluency

Fluency is important in reading as it aids comprehension. Children with Learning Disabilitiesusually read by using clues from the context of the passage. In order to do this there has to be some degree of fluency and understanding. Fluency helps to provide understanding and makes it easier for the reader to use context. One way to aid fluency is to use a text that is below the child's reading age, or texts that are characterised by the high interest level and low level vocabulary (hi-lo readers). Generally there may be a reluctance to read for pleasure and any interest at all, in any type of reasonable reading material, should be encouraged.

Comprehension

Reading comprehension can be a problem for the child with Learning Disabilitiesbecause of both the difficulties with fluency and the problems in decoding. Yet if the text is read to the child they will very likely understand it as their listening comprehension is usually better than their reading comprehension. In fact reading a text to the child, or discussing the text through pre-reading discussion with the child, can each help to develop reading comprehension.

Sequencing

Children with Learning Disabilitiesoften have a sequencing difficulty. This means that they may get letters, or parts of a word, in the wrong order. For example the word *preliminary* may be read as *preinlimary.*

Spelling

The child with Learning Disabilitiesmay show some or all of the following:

- difficulty remembering spelling rules,
- phonological errors, for example using the letter ‘f’ for the sound ‘ph,’
- letters or groups of letters out of sequence,
- inconsistent use of some letters with similar sounds such as ‘s’ and ‘z,’
- difficulty with word endings for example using ‘ie’ for ‘y’
- confusion or omission of vowels

Writing

Expressive writing: the child with Learning Disabilitieswill usually show a reluctance to write a lengthy piece of work. Additionally it may be difficult for him/her to identify and develop key points. This means that the written piece may be rambling and poorly organised. This underlines the need top provide dyslexic children with a structure when engaging in expressive and creative writing.

Handwriting

Children with Learning Disabilitiesmay have an inconsistent writing style and the slope and characteristics of the writing style can vary within the same sentence. There may be an inconsistent use of capital and small letters. Additionally the writing speed may be slow, deliberate and hesitant. Sometimes the child may adopt an unusual writing grip or sitting position.

Memory: children with Learning Disabilitiesmay display indicators of a;

- poor short-term memory, which means they will have difficulty remembering lists,
- poor working memory – that is using and processing two or more pieces of information at the same time

- poor long- term memory which could be due to confusion at the time of learning, or poor organisational strategies.
- Recalling information that has been recently learnt but not used a great deal. This is because although they may have learnt the information but it has not been consolidated. The child therefore will not have what is known as automaticity in the information that has been learnt. There is some evidence to suggest that children with Learning Disabilitieshave poor automaticity and can take longer than expected to achieve automaticity in learning. Usually in order to achieve automaticity the learner needs to use the information in as many different contexts as possible and the information will then be consolidated. Children with Learning Disabilitiesin order to do this need a significant amount of over learning.

Children with Learning Disabilitiesmay also show difficulties in the following:

Organisation

- poor organisational strategies for learning,
- poor organisation of timetable, materials equipment and items needed for learning, such as remembering and organising homework notebook.

Motor development

- may have a difficulty with co-ordination and tasks such as tying shoelaces, hopping and skipping.
- They may accidentally knock into furniture in the classroom, trip and fall over frequently.

Speech Development –they may show;

- Confusion over similar sounds in words,
- poor articulation,
- difficulty blending letters and sounds into words,
- poor awareness of rhyme,
- poor syntactic structure,
- naming difficulties –ie remembering the names of objects.

Comment

It is important therefore to appreciate that there are a range of dimensions that can have an impact on the child with Learning Disabilitiesand need ot be considered when planning strategies and approaches for teaching. While much research activity is focussed on the neurological dimensions we musty not lose sight of the need to ensure that results from research inform classroom and teaching practices. Finding out why a child is not learning is only part of the picture – we need to ensure that teaching and learning procedures are in place, funded and supported and implemented by trained and enlightened professionals with a clear understanding of the barriers and the challenges faced by students with dyslexia.

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