



Literature Review: An International Perspective on Dyslexia

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Executive Summary

Background

Literacy is one of the competencies necessary for effective participation in modern life¹ and is a prerequisite for the achievement of many other essential competencies, both generic and specific. It underpins access to all learning areas across the curriculum. New Zealand has a good reputation for the literacy achievement of its students, but it also has a system where a number of learners are not achieving well by international standards². There is a group of students who experience persistent and on-going difficulties in literacy, and recently there have been particular questions as to whether the current education system is meeting the needs of a group of students with specific learning disabilities (SLD), in particular those commonly referred to as dyslexia.

Dyslexia is an often misunderstood, confusing term for reading difficulties, but despite the many confusions and misunderstandings the term dyslexia is commonly used by a number of medical personnel, researchers and the general public. Identifying an individual as 'dyslexic' can help them to understand their experiences but this label does not give any information or direction on how to support and teach this individual to read and write. For this reason the term dyslexia is often avoided in educational contexts with preference given to the terms 'learning disability', 'specific learning disability' or 'specific learning difficulty'. However, the continued use of the term dyslexia in research and by many members of the general public means that these phrases are often used interchangeably, as will be the case in this review.

The purpose of this literature review is to examine available international research and information over the last decade on dyslexia, with particular attention to the students that have been identified as “dyslexic”, the tools commonly used to identify these students, the support services that are available to these students and who provides these services. The overarching goal is to gather evidence on the effectiveness of interventions used to improve literacy levels of dyslexic students or students at risk of dyslexia in order to inform evidence based policy development within the New Zealand Ministry of Education.

As part of the peer review process for this literature review, James Chapman and Bill Tunmer from the College of Education at Massey University, Palmerston

¹ OECD: Selecting and Defining Key Competencies and Ministry draft curriculum

North were asked to provide feedback on the literature review in respect of the methodology, structure and comprehensiveness of the review; strengths of the review and/or any obvious gaps in terms of literature related to dyslexia; and the usefulness of the review. A summary of the issues raised during the peer review process can be found in appendix 3.

Methodology

Over the last decade there has been a considerable amount of research and writing within the area of dyslexia. The scope of this review was limited to the objectives stated in the section above. In particular, this project required a methodology that would enable location of high quality studies that demonstrated a clear relationship between literacy outcomes of dyslexic students or students at risk of dyslexia and specific components of teaching or support.

Searches were conducted using a number of databases and research web pages and a combination of key words. The abstracts or citations were screened and articles selected based on relevance to the review. The articles were sorted into categories, read by the author and rated for their validity in terms of the project brief. Articles describing experimental research studies were also rated according to criteria that support rigorous evidence³. However a number of studies fell short of these inclusion criteria. The scope of the review was expanded to include studies that fell short on one or two of these criteria, to ensure a reasonable pool of studies to consider and identify the best available evidence. (Refer to Appendix 3, numbers 1 to 3 for peer review comments)

Findings

Analysis across the research studies and reviews has identified a number of key findings from the authors that add to the knowledge base about dyslexia. Some congruency of findings between research studies has also been identified that are likely to contribute to the improved literacy levels of dyslexic individuals.

² PIRLS 2001, PISA 2000

³ Randomised controlled trials, clear description of the intervention, who administered it, who received it, the costs, the sample size, the outcome measures are valid, the size of any effects are reported.

Definitions of dyslexia

The research on dyslexia revealed that there is no agreement on the definition of dyslexia across English speaking countries, nor is there agreement on its causes, subtypes and characteristics. However, there was a significant amount of evidence in the research reviewed to substantiate the following:

- *Dyslexia involves an unexpected difficulty in learning to read.* Although the exact causes of dyslexia are still unknown, an underlying theme evident across all the definitions is the notion that dyslexia involves an unexpected difficulty in learning to read. (Aaron, 1997; Stanovich, 1998, 1999; Lyon et al., 2003; Klassen, 2002, 2005; British Psychological Society, 1999; Velluntino et al., 2004)
- *Dyslexia is a specific learning disability.* It has become widely accepted that dyslexia is a specific learning disability and has biological traits that differentiate it from other learning disabilities. (Lyon et al., 2003; Klassen, 2002, 2005; Ramus et al., 2003; Stein 2001; Velluntino et al., 2004)
- *Definitions involve a phonological deficit.* Over the last decade, definitions of dyslexia have moved away from using IQ discrepancy models in the definition and moved towards accepting that a phonological deficit should be included in the definition. (Aaron, 1997; Stanovich, 1998, 1999; Lyon et al., 2003; Klassen, 2002, 2005; British Psychological Society, 1999)

Causes and effects of dyslexia

The research on dyslexia revealed that there is no agreement on the causes and effects of dyslexia. However, the research reviewed revealed a significant body of evidence to support the following claims:

- *There are three main deficit theories on what causes the characteristics of dyslexia:*
 - The **phonological deficit** theory explains difficulties dyslexic individuals show linking sounds with symbols in reading and spelling.
 - The **cerebellar deficit** theory suggests there is a problem in central processing linked to learning and automaticity.
 - The **magnocellular deficit** theory suggests that problems arise as a result of visual or auditory deficits.

(Ramus et al., 2003; Lyon et al., 2003; Shaywitz et al., 1999; Blomert et al., 2004; Padget, 1998; Frith, 1997; Nicolson et al., 2001; Heiervang et al., 2002; Pammer & Vidyasagar, 2005; Stein, 2001)

- *Problems with phonology are associated with dyslexia.* The phonological deficit theory as the underlying cause of dyslexia has gained wide acceptance and is by far the most researched and developed theory. Even though there is unanimous agreement that phonology is associated with dyslexia it is becoming clear that phonology is not the only problem. (Ramus et al., 2003; Lyon et al., 2003; Shaywitz et al., 1999; Blomert et al., 2004; Padget, 1998; Frith, 1997; Snowling, 2000)
- *The emotional response of a dyslexic individual becomes more significant with age.* Children and adults with reading difficulties have an enhanced likelihood of associated emotional and social difficulties. Young at risk or dyslexic children have similar levels of self-esteem as normal children, however without effective instruction and support their self-esteem decreases, and after the age of 10 it is extremely difficult to help these children develop a positive self image. Thus, without recognition of associated emotional or social problems it is possible that the gains made to treat the dyslexia will diminish if adequate support to assist the dyslexic individual is not offered. (Hales, 2001; Ryan, 1994; Muijs, 1997; Esser & Schmidt, 1994; Lindsay & Dockrell, 2000)

The literature reviewed revealed limited or contradictory evidence in relation to the following claims:

- *Dyslexia is a neurological disorder with a possible genetic origin.* Brain imagery studies have shown differences in the anatomy, organisation and function of a dyslexics brain, but it is unknown whether these are a cause or effect of the reading difficulty. A gene may have been identified that is responsible for dyslexia and as this gene is dominant it would make dyslexia an inheritable condition. (Ramus et al., 2003; Lyon et al., 2003; Cardon et al.; 1994; Grigenko et al., 1997; Field & Kaplan, 1998; Habib, 2000)
- *Dyslexia is more common in males than females.* A number of reports suggest that dyslexia is more frequent in males than females ranging from 1.5:1 to 4.5:1 but it is unclear whether this observation is a result of selection factors and/or bias. Until further controlled research is carried out the consensus is

that dyslexia occurs in both sexes with equal frequency. (Wadsworth et al., 1992; Shaywitz et al., 1990; Ansara et al., 1981; Miles et al., 1998)

- *Language of instruction.* From the small amount of available literature, the strongest consensus is that the manifestations of dyslexia differ by language. The underlying causes of dyslexia are thought to be universal but it is likely that the core deficit differs with orthographic consistency. (Harris & Hatano, 1999; Ziegler & Goswami, 2003, 2005; Ziegler et al., 2003; Landerl & Wimmer, 2000; Helmuth, 2001, Wimmer et al., 1998)
- *Cost effectiveness.* Any intervention is more cost effective with younger students that are at risk of reading difficulties, compared to older students that have been identified with a reading disability. Also, interventions of 25 hours or more tended to be very poor in terms of cost effectiveness, especially for older children with known disabilities. (Fawcett, 2002; KPMG Foundation, 2006)

Enhancing literacy levels of dyslexics

The research reviewed revealed a significant body of evidence to support the following claims:

- *Early detection.* Early success in reading skills usually leads to later success in reading, while failing to read before the third or fourth year of schooling may be indicative of life-long reading problems. Thus, early detection is best made in early childhood or during the first year of school where the gap that separates the students at risk of reading failure and the students that are likely to be successful readers is small. Early detection alone however will not improve literacy levels unless the student receives appropriate early intervention before reading problems become entrenched. (Juel, 1988; Stanovich, 1986; Velluntino et al., 2004; Tunmer et al., 2003; Narayana & Xiong, 2003; Fuchs & Fuchs, 2001; Fawcett et al., 1998; Speece et al., 2003; Whiteley et al., 2002; Torgesen, 1998)
- *Maximising the chances for early identification of all at risk students.* Tests that should be administered for early detection aim to identify students at risk of dyslexia but make no attempt to diagnose dyslexic students. Tests administered at a young age are more inaccurate than tests administered at an older age. Early identification procedures need to be carried out with as many children as possible to maximise the chances for identification of all at risk

students. (Torgesen, 1998; Singleton et al., 1996; Woodcock et al., 2001; Fuchs & Fuchs, 2001; Nicolson & Fawcett, 1996)

- *Determine a student's strengths and weaknesses.* Assessment tools that determine a student's strengths and weaknesses in a range of areas can be used to design individual intervention strategies that target the identified weakness areas. These have greater benefit in an educational setting than a full psychometric test as they are relatively simple and quick screening methods that can be carried out by non-specialist staff. (Torgesen, 1998; Singleton et al., 1996; Woodcock et al., 2001; Fuchs & Fuchs, 2001; Nicolson & Fawcett, 1996; Wechsler, 2004; Velluntino et al., 2004; Whiteley et al., 2002)
- *Early intervention.* Research has not been able to identify one type of intervention as better than another for teaching at risk or dyslexic readers, although all methods seem to work for some learners. However, it has been found that early intervention, designed to improve the specific needs of the individual, reduces the prevalence of dyslexia compared to individuals who did not receive intervention or support. Students who had early intervention compared to remediation at an older age show bigger gains in reading accuracy and fluency. It is also easier for them to catch up with their peers, and the long-term cost of their education is lower. (Schneider et al., 1999; Borstrom & Elbro, 1997; National Reading Panel, 2000; Torgerson et al., 2006; O'Connor, 2000)
- *Instruction in phonological awareness and phonics at an early age.* Timing issues with regard to preventative instruction have not been completely resolved by research but at risk students who had intervention in phonological awareness and phonics at an early age compared to remediation at an older age show bigger gains in reading accuracy and fluency. Also teaching phonological awareness significantly improves the reading of at risk or dyslexic students compared to an instruction that lacks attention to phonological awareness. (Schneider et al., 1999; Borstrom & Elbro, 1997; National Reading Panel, 2000; Fawcett, 2002; Torgerson et al., 2006; Leafstedt et al., 2004)
- *Teaching focused on individual learners needs.* Identification of effective intervention methods for at risk or dyslexic readers is a challenging process because every person with dyslexia is different. To be effective these interventions need to be focused on each individual learner's strengths and weaknesses, and have the flexibility to change with the needs of the

individual. (Whiteley et al., 2002; Given & Reid, 1999; Torgesen, 2000; Velluntino et al., 2004; Alexander & Slinger-Constant, 2004)

- *Increased intensity.* It is agreed that once reading difficulties have been identified teaching efforts must immediately be intensified. However, research has not revealed what level of intensity, frequency or instructor to student ratio is most effective, and these are likely to vary across interventions. (Pressley, 2001; Hiebert & Taylor, 2000; O'Connor, 2000; Torgesen, 1998, 2001, 2002; National Reading Panel, 2000; Velluntino et al., 2004; Alexander & Slinger-Constant, 2004)
- *On-going assessment and support.* Dyslexia is a lifelong disability and research has shown that there are no quick fixes for dyslexic students. Owing to the dynamic course of language development and the changes in language demands over time, even after a child has demonstrated a substantial response to treatment, their subsequent progress should be carefully tracked to ensure optimal progress toward the development of functional reading and written language skills. (Pressley, 2001; Hiebert & Taylor, 2000, Shaywitz et al., 1999; Velluntino et al., 2004; Torgesen, 1998)

The literature reviewed revealed limited or contradictory evidence in relation to the following claims:

- *Fluency instruction.* Although intuitive, there is insufficient evidence to suggest that encouraging children to silent read more has an effect on fluency, accuracy or comprehension; however guided repeated oral reading shows positive signs of improving word recognition, fluency and comprehension. (National Reading Panel, 2000; Fawcett, 2002)
- *Comprehension instruction.* Preliminary findings with learning disabled readers suggest that comprehension develops from vocabulary strength, fluent word reading and a combination of strategies for helping students connect with and think about the text. (National Reading Panel, 2000; Fawcett, 2002; Swanson & Hoskyn, 2000)
- *Computer assisted instruction.* Computer technology is showing great potential for improving reading achievement, with promising approaches for promoting word recognition and vocabulary and comprehension development. (Swanson & Hoskyn, 2000; Pressley, 2001; National Reading Panel, 2000)
- *Teaching strategies.* Results suggest that learners benefit from teachers who are able to offer a range of teaching strategies and have access to a wide range

of instructional materials and resources. (Swanson & Hoskyn, 2000; Department of Education and Skills, 2004a; Lyon et al., 2003)

- *Adults can be taught using the same elements identified to teach children.* It is never too late for individuals with dyslexia to learn to read and use other language skills better. However, rigorous research studies to determine the most effective interventions for adolescents and adults are just underway. Initial results show that the same elements identified to teach children can be used for older individuals, and intensive, evidence based remedial interventions can improve reading accuracy in older reading disabled or dyslexic individuals, but these are less effective at closing the fluency gap. (Alexander & Slinger-Constant, 2004; Velluntino et al., 2004; Ramus et al., 2003)

In conclusion, it can be seen that over the last decade a large amount of research on dyslexia has been undertaken, but how these findings fit together to form an overall picture still remains elusive. This literature review has identified a number of key factors that the research has found to contribute to improving the literacy levels of at risk or dyslexic readers. However, due to the limited number of rigorous research studies carried out in New Zealand the impact of these findings on improving literacy levels of at risk or dyslexic New Zealand students needs to be researched further. The current challenge is to design and undertake rigorous research studies that assess the effectiveness of these international findings in a New Zealand setting.

1. Introduction

The term “dyslexia” was coined in 1887 to refer to a case of a young boy who had a severe impairment in learning to read and write in spite of showing typical intellectual and physical abilities. Research on dyslexia throughout the early 20th century focused on the idea that dyslexia stemmed from a visual deficit that involved reading words backwards or upside-down. However, in the 1970s it was suggested that dyslexia stemmed from a deficit in processing the phonological form of speech, which resulted in individuals having difficulty associating word sounds with visual letters that make up the written word. More recent studies using modern imaging techniques have shown differences in the way the brain of a “dyslexic” person develops and functions. Now, even after a century of research, dyslexia is still one of the most controversial topics in the field of developmental neurology, psychology and education. The controversy arises from the incomplete and varying definitions of dyslexia and from the contradictory theories surrounding its causes, subtypes and characteristics.

Dyslexia is widely accepted to be a specific learning disability and has biological traits that differentiate it from other learning disabilities. Dyslexia is the most common specific learning disability and is estimated to affect from 3 to 20 % of the population around the world. The Specific Learning Disabilities Federation of New Zealand (SPELD NZ) which provides specialist tutoring services within New Zealand estimate that 7.1 % of all students have specific learning disabilities, which equates to approximately 55,000 school age children. However there is no empirical evidence to confirm this statement. Findings from the 1996 International Adult Literacy survey (Chapman et al., 2003) have 7.7 % of New Zealand adults identifying themselves as having a reading disability; based on today’s population this equates to around 265,000 adults. However, as the survey only focused on reading problems and not all possible learning difficulties it is reasonable to assume that at least 10 % of the population experiences some type of specific learning disability.

Whilst the term dyslexia is used in some countries as a type of specific learning disability, there is no international agreement on its definition and diagnosis. The New Zealand government does not officially recognise the use of the term dyslexia to define literacy difficulties. Currently, the Ministry of Health does not recognise dyslexia as a medical condition but recognises that it needs diagnosis and

treatment, and as it is considered a developmental disorder the preferred term is specific learning disability⁴. The Ministry of Education does not wish to develop an education system which defines and categorises students in terms of their learning disabilities, but prefers a system that makes assessments on their needs for additional support. In this regard, the Ministry of Education does not specifically recognise the use of the term dyslexia in the school context because of the issues associated with labelling students, and instead, individual needs are identified and appropriate interventions across a range of learning difficulties are implemented.

Provisions have been made in the *Special Education 2000* policy for schools to assist children with moderate learning difficulties and a Special Education Grant (SEG) is also paid directly to schools so that they might provide instructional adaptations to improve the educational achievement of those students with learning difficulties. Remedial reading programmes offered to New Zealand students with reading difficulties include Reading Recovery (RR), and specialist support is provided through the Resource Teachers: Literacy (RT:Lits) and Resource Teachers: Learning and Behaviour (RT:LBs). However, there is a group of students who are not making progress in literacy in spite of good teaching and, where accessed, any intervention. It is possible that this may result because of learning disabilities that teachers know little about.

Recently, there have been particular questions as to whether these interventions are meeting the needs of a group of students with the specific learning disability recognised as dyslexia in other countries. The purpose of this literature review is to examine teaching initiatives and international research over the past decade on dyslexia, and to see whether there is evidence that these international initiatives have improved the literacy levels of “dyslexic” students.

⁴ Ministry of Health (July 2006)

2. International Definitions

Each of the following definitions of dyslexia, from English speaking nations, emphasise a slightly different feature or view about the nature or cause of the difficulty. It should be noted that the term ‘dyslexia’ is mostly a medical term and often avoided in educational contexts, with preference in North America given to the term ‘learning disability’ or ‘specific learning disability’. In the UK and Australia the term ‘specific learning difficulty’ is preferred. However, the continued use of the term ‘dyslexia’ in research and by the public means that these phrases are often used interchangeably, as will be the case in this review.

In the USA the Office of Special Education and Rehabilitative Services within the US Department of Education provides funding and is committed to improving results and outcomes for people with disabilities of all ages. In keeping with the governments *No Child Left Behind agenda* (US Department of Education, 2001) and the *Individuals with Disabilities Education Act* (US Department of Education, 2004) the Office of Special Education and Rehabilitation services provides a wide array of supports and services to parents, individuals, school districts and states to serve individuals with learning disabilities.

In the USA operational definitions of learning disabilities are undergoing a move away from the traditional IQ achievement discrepancy definition to identification based on other markers (Aaron, 1997; Stanovich, 1998, 1999). The move away from traditional IQ achievement is demonstrated by looking at the change in the National Institute of Child Health and Human Development (NICHD) definition of dyslexia over the past few decades. In the 1980s they had an exclusionary definition of dyslexia:

‘If a child’s difficulty with reading could not be explained by low intelligence, poor eye sight, poor hearing, inadequate educational opportunities, or any other problem, then the child must be dyslexic.’

This definition was unsatisfactory to a number of parties including parents, teachers and researchers, and once research in dyslexia began at NICHD, the definition was revised. In 1994 a working definition of dyslexia was put forward (Lyon et al., 2003):

‘Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin characterised by difficulties in single word decoding, usually reflecting insufficient

phonological processing. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalised developmental disability or sensory impairment. Dyslexia is manifest by variable difficulty with different forms of language, often including, in addition to problems with reading, a conspicuous problem with acquiring proficiency in writing and spelling.'

This working definition was revised in 2003 to the current definition:

'Dyslexia is a specific learning disability that is neurobiological in origin. It is characterised by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary, consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.'

The exclusionary definition adopted in the 1980s has now moved towards a more non-categorical definition. Dyslexia is now identified as a specific learning disability and recognises the advances in understanding of the neural basis for dyslexia since the previous definitions. The new definition expands on the difficulties in single word decoding in the previous definition to specifically include difficulties with accurate word recognition and decoding. It also recognises poor spelling and the inability to read fluently as characteristics of dyslexia.

New in the current definition is the concept that a child needs to have been provided with effective classroom instruction. The addition of the final sentence describes the consequences of phonological difficulties and provides a causal model that can guide assessment efforts. The International Dyslexia Association has also adopted the 2003 NICHD definition of dyslexia.

The history of dyslexia in Canada can be viewed as paralleling that in the USA (Klassen, 2002). The funding for dyslexic students sits within the special education division, the definitions of dyslexia have been similar and over the last few years have come under increased pressure to be revised. In the USA and Canada operational definitions of learning disabilities are set by the individual states and

provinces respectively, and thus there is considerable variation of the services and definitions used to determine access to service. These inconsistencies have added to the confusion surrounding the learning disabilities label (Shaw et al., 1995). In the Canadian education system dyslexia is classed under the category of learning disabilities and all but two of the provinces define a learning disability through the use of IQ scores in conjunction with discrepant achievement. Even though there is variation between provinces on the definition of learning disability, the current official national definition of learning disabilities is taken to be the 2002 revision definition adopted by the Learning Disabilities Association of Canada (Learning Disabilities Association of Canada, 2002):

"Learning Disabilities" refer to a number of disorders which may affect the acquisition, organization, retention, understanding or use of verbal or nonverbal information. These disorders affect learning in individuals who otherwise demonstrate at least average abilities essential for thinking and/or reasoning. As such, learning disabilities are distinct from global intellectual deficiency.

Learning disabilities result from impairments in one or more processes related to perceiving, thinking, remembering or learning. These include, but are not limited to: language processing; phonological processing; visual spatial processing; processing speed; memory and attention; and executive functions (e.g. planning and decision-making).

Learning disabilities range in severity and may interfere with the acquisition and use of one or more of the following:

- *oral language (e.g. listening, speaking, understanding);*
- *reading (e.g. decoding, phonetic knowledge, word recognition, comprehension);*
- *written language (e.g. spelling and written expression); and*
- *mathematics (e.g. computation, problem solving).*

Learning disabilities may also involve difficulties with organizational skills, social perception, social interaction and perspective taking.

Learning disabilities are lifelong. The way in which they are expressed may vary over an individual's lifetime, depending on the interaction between the demands of the environment and the individual's strengths

and needs. Learning disabilities are suggested by unexpected academic under-achievement or achievement which is maintained only by unusually high levels of effort and support.

Learning disabilities are due to genetic and/or neurobiological factors or injury that alters brain functioning in a manner which affects one or more processes related to learning. These disorders are not due primarily to hearing and/or vision problems, socio-economic factors, cultural or linguistic differences, lack of motivation or ineffective teaching, although these factors may further complicate the challenges faced by individuals with learning disabilities. Learning disabilities may co-exist with various conditions including attentional, behavioural and emotional disorders, sensory impairments or other medical conditions.

For success, individuals with learning disabilities require early identification and timely specialized assessments and interventions involving home, school, community and workplace settings. The interventions need to be appropriate for each individual's learning disability subtype and, at a minimum, include the provision of:

- *specific skill instruction;*
- *accommodations;*
- *compensatory strategies; and*
- *self-advocacy skills.'*

However, a specific definition of dyslexia is also used by the Canadian government which is taken from the British Columbia Health Guide (British Columbia Health Guide, date unknown):

'Dyslexia is defined as having difficulty with the alphabet, reading, writing and spelling in spite of normal to above average intelligence, conventional teaching, and adequate socio-cultural opportunity. Dyslexia is thought to be both genetic and hereditary. Dyslexia is not caused by poor vision. Dyslexia is identified following psychological and educational tests that determines language and other academic abilities, IQ and problem solving skills, and is only identified if the reading disability is not a result of another condition.'

The Canadian Dyslexia Association has a variation on this and states that:

'Dyslexia results from a different brain organisation. This may cause problems with reading, writing, spelling and speaking, despite average or superior intelligence, traditional reading instructional and socio-cultural opportunity. The biological condition of dyslexia is hereditary.'

In British Columbia changes in the way learning disabilities are defined have recently attracted attention as a review of special education services in British Columbia has been carried out (Siegel & Ladyman, 2000). In this review there is a significant change from the definitions of the last three decades and the proposed changes reflect some of the most current research. The authors argue that 'a significant number of studies examining learning disabilities have found no difference in the reading (including reading comprehension), spelling and phonological skills between learning disabled individuals with high and low IQ scores, and that there are no differences between dyslexics and poor readers on measures of the process directly relating to reading.' These changes mean that identification of learning disabilities will occur at the classroom level by teachers using standardised tests. It is thought that this process will detect most, if not all learning disabilities.

British Columbia appears to be leading the way in North America in the move to eliminate the need for IQ tests in the learning disabilities identification process with the aim to shift emphasis from eligibility to appropriate intervention (Pasternack, 2002). However, as almost all the other American states and Canadian provinces use IQ tests as part of the learning disability identification process, the resolve to move away from this practice has brought about confusion about the nature and structure of learning disability identification practices in the future (Klassen, 2002).

Education systems outside North America have definitions in which discrepancy techniques are not used in identifying learning disability. These countries have either never adopted the IQ achievement discrepancy or have already moved away from this method of identifying students with dyslexia or learning difficulties.

In Britain the funding for children with dyslexia sits within the Special Education Needs and Disability Division of The Department of Education and Skills. The governments strategy for special education needs, *Removing Barriers to Achievement* (Department of Education and Skills, 2004), sets out the governments vision for giving children with special needs and disabilities the opportunity to succeed. This strategy has built on the proposals for the reform of children's services set out in the governments' key policy *Every Child Matters*.

In Britain the term 'dyslexia' was previously avoided in education with preference given to the term 'specific learning difficulties.' However, as the term dyslexia was embedded in everyday language it has gradually gained acceptance and has recently been included in key policy documents (Department of Education and Skills, 2001, 2004). The Department of Education and Skills worked closely with the British Psychological Society on a report to clarify the concept of dyslexia within an educational context (British Psychological Society, 1999). This report expressed the need to define dyslexia in a descriptive way without explanatory elements. A working definition was proposed that would be the starting point to different rationales and research initiatives. This working definition is the current definition of the British Psychological Society:

'Dyslexia is evident when accurate and fluent word reading and/or spelling develops very incompletely or with great difficulty. This focuses on literacy learning at the 'word level' and implies that the problem is severe and persistent despite appropriate learning opportunities. It provides the basis of a staged process of assessment through teaching.'

It has been reiterated that this is only a descriptive working definition and not an operational definition. The following two definitions by other British associations use explanatory elements in their definitions of dyslexia. The British Dyslexia Association definition is that:

'Dyslexia is best described as a combination of abilities and difficulties that affect the learning process in one or more of reading, spelling, writing. Accompanying weaknesses may be identified in areas of speed of processing, short-term memory, sequencing and organisation, auditory and/or visual perception, spoken language and motor skills. It is particularly related to mastering and using written language, which may include alphabetic, numeric and musical notation.'

The British Dyslexia Institute states that:

'Dyslexia causes difficulties in learning to read, write and spell. Short-term memory, mathematics, concentration, personal organisation and sequencing may also be affected. Dyslexia usually arises from a weakness in the processing of language based information. Biological in its origin, it tends to run in families, but environmental factors also contribute. Dyslexia can occur at any level of intellectual ability. It is not the result of

poor motivation, emotional disturbance, sensory impairment or lack of opportunities, but it may occur alongside any of these. The effects of dyslexia can be largely overcome by skilled specialist teaching and the use of compensatory strategies.'

In Australia, dyslexia advocacy groups have had little influence on dyslexia identification practices within the education system (Elkins, 2001). During the 1960s and 1970s dyslexia was a funded category with identified students receiving support through remedial classes. The students at this time were identified as having average intelligence but were two years behind their peers in reading (Klassen et al., 2005). However, a formal government committee set up in the early 1970s argued against formalising a definition of learning disability, and against categorical funding for those experiencing specific learning difficulties. Australia currently has a system similar to New Zealand in which a non-categorical/low achievement approach to the funding of learning disabilities is taken. This means that students with specific learning disabilities are not individually funded, but funding and a variety of intervention programs are offered to help increase the literacy skills of low achieving students. The main source of this funding is through the Literacy, Numeracy and Special Learning Needs Programme, which is an Australian Department of Education literacy and numeracy initiative.

Across the English speaking nations the definitions of dyslexia vary considerably. However, over the last decade there has been a move away from using discrepancy models in the definition of dyslexia and a move towards accepting that a phonological deficit should be included in the definition. It has also become widely accepted that dyslexia is a specific learning disability and has biological traits that differentiate it from other learning disabilities. However, the exact causes of dyslexia are still unknown and there is no agreement between communities and countries on its definition, subtypes and characteristics. Even though all the definitions vary the underlying theme that is evident through all the definitions is the notion that dyslexia involves an unexpected difficulty in learning to read. (Refer to appendix 3, number 4 for peer review comments)

3. Causes and Characteristics of Dyslexia

The international definitions of dyslexia vary considerably between countries and associations with no agreement on its causes and characteristics. The only consensus between the definitions is the notion that dyslexia involves an unexpected difficulty in learning to read; where reading itself can be defined as the process of extracting and constructing meaning from written text for some purpose (Vellutino et al., 2004). Even though this is the one agreed characteristic that individuals with dyslexia will display, there are numerous other possible characteristics reported in the literature that may be an indication of dyslexia. These include, but are not limited to, difficulty with (Davis & Braun, 1994; British Psychological Society, 1999; Bright Solutions for Dyslexia, date unknown):

- formation of letters;
- naming letters;
- associating sound (phonetics) with the symbol (grapheme);
- writing letters of the alphabet in the proper sequence;
- spelling, writing;
- finding a word in the dictionary;
- following instructions;
- expressing ideas in writing;
- distinguishing left from right, east from west;
- telling time, days of week, months of year;
- short term or working memory;
- inconsistent performance and grades;
- lack of organisation;
- automatising of tasks; and
- balance;

It should be noted that the characteristics of dyslexia can vary greatly from one individual to another, and not all individuals will have problems with all these difficulties. Also individuals who do have difficulties with these skills may not be dyslexic. (Refer to appendix 3, number 5 and 6 for peer review comments).

The exact causes of dyslexia which result in the display of some of the characteristics shown above are still not completely clear. However, from the research literature there are three main deficit theories that may cause the identified

characteristics of dyslexia. These deficit theories are (i) the phonological theory (Ramus et al., 2003; Lyon et al., 2003; Shaywitz et al., 1999; Blomert et al., 2004; Padget, 1998; Frith, 1997), this is by far the most researched and developed theory over the past decade; (ii) the cerebellar theory (Ramus et al., 2003; Nicolson et al., 2001); and (iii) the magnocellular (auditory and visual) theory (Ramus et al., 2003; Blomert et al., 2004; Heiervang et al., 2002; Pammer & Vidyasagar, 2005; Stein, 2001). From a decade of literature there are different versions of each theory, which have developed over time. Described here is, as far as the author is aware, the current, most prominent version of each theory. (Refer to appendix 3, number 7 for peer review comments).

(i) The Phonological Theory

This theory is based around speech sounds, and postulates that dyslexic individuals have difficulties in representing, storing and/or retrieving these sounds. In dyslexics the difficulty in reading in relation to this theory is a consequence of impairment in the ability to learn to read an alphabetic system which requires learning the grapheme-phoneme relationship. In simple terms there is impairment in the ability of relating written letters to their speech sounds. This theory implies a straightforward link between a cognitive deficit and difficulty in reading.

Support for this theory comes from evidence that dyslexic individuals perform particularly poorly on tasks requiring phonological awareness. There is also evidence that suggests dyslexics have poor verbal short-term memory and slow automatic naming which suggests a more basic phonological deficit (Snowling, 2000; Ramus et al., 2003). At a neurological level, anatomical work and brain imaging clearly show that a dysfunction with the left side of the brain is the basis for the phonological deficit (Lyon et al., 2003; Temple et al., 2001; Marshall, 2003; Frith, 1997). However, despite all the evidence supporting the phonological theory the quote taken from Frith (1997) sums up the current status of the theory; “the precise nature of the phonological deficit remains tantalisingly elusive.”

(ii) The Cerebellar Theory

This theory postulates that the dyslexics’ cerebellum is mildly dysfunctional and that a number of cognitive difficulties will ensue, including balance; motor skill; phonological skill and rapid processing (Nicolson et al., 2001; Ramus et al., 2003;

Fawcett, 2001). As a number of these skills are not language based, the phonological theory could not explain all the problems associated with dyslexia.

Problems in motor skill and automatization point to the cerebellum, but until recently this was largely dismissed in dyslexia because there were no known links between cerebellum and language. However, there is now evidence that the cerebellum is involved in both language and cognitive skill, including involvement in reading (Fulbright et al., 1999). Support for this theory comes from evidence of poor performance of dyslexics in a variety of motor, time estimation and balance tasks (Fawcett et al., 1996; Fawcett & Nicolson, 1999). Brain imaging studies have also shown anatomical, metabolic and activation differences in the cerebellum of dyslexics (Brown et al., 2001; Ramus et al., 2003).

(iii) The Magnocellular (Auditory and Visual) Theory

Historically, visual and auditory disorders were considered separately but there is now agreement between their advocates that they come under the more general area of a magnocellular dysfunction (Stein & Walsh, 1997; Ramus et al., 2003; Tallal et al., 1998). This theory postulates that the deficit lies in the perception of short or rapidly varying sounds or difficulty processing the letters and words on a page of text. This theory does not exclude a phonological deficit, but emphasises the visual and auditory contribution to the reading problem.

Evidence to support this theory includes differences in the dyslexic brain anatomy in both visual and auditory magnocellular pathways (Stein, 2001), and the co-occurrence of visual and auditory problems in certain dyslexics (van Ingelghem et al., 2001).

In summary the phonological theory explains many of the difficulties which dyslexic individuals show linking sounds with symbols in reading and spelling. The cerebellar theory suggests there is a problem in central processing linked to learning and automaticity. The magnocellular theory suggests that the problems a dyslexic individual may display are a result of visual and auditory deficits.

Each theory also has weaknesses or problems associated with it. The phonological theory does not explain the occurrence of sensory or motor disorders that occur in a significant proportion of dyslexics, while the magnocellular theory suffers mainly from its inability to explain the absence of sensory and motor disorders in a significant proportion of dyslexics. The cerebellar theory presents both types of

problems. Even though these theories are usually considered separately, it is evident that there is a synergy between these theories, and of course, it is possible that all three theories are true for different individuals.

A number of studies carried out since the turn of the century have emerging findings that may make up another theory of dyslexia which is not based on a deficit theory, this is known as the transactional theory of dyslexia. The transactional view draws on work based on cognition (Anderson, 2003), socio-cultural (Gee, 2001) and learning theories with a more instructional focus (Clay, 2001). In this regard it postulates that reading ability is not a property of the reader but varies depending on the complex social contexts and events in which it occurs. The transactional view on reading difficulties advocates that understanding the natural variability of readers is more important and productive than diagnostic categories (McEneaney et al., 2006). (Refer to appendix 3, number 8 for peer review comments).

From advances in anatomical and brain imagery studies it has been recognised, but not universally, that dyslexia is a neurological disorder with a possible genetic origin, since it occurs most often in families (Ramus et al., 2003; Lyon et al., 2003). Some researchers think they have identified a gene responsible for dyslexia, and as this gene is dominant it makes dyslexia an inheritable condition (Cardon et al., 1994; Grigorenko et al., 1997). More current research has however found no evidence of an association or linkage between the identified gene and dyslexia (Field & Kaplan, 1998). So the genetic origin of dyslexia, if there is one, is still a hotly debated subject and continues to be the focus of modern day research.

Researchers have agreed that brain imagery studies have shown differences in the anatomy, organisation and function of a dyslexic person's brain, but it is unknown whether these differences are a cause or effect of the reading difficulty (Lyon et al., 2003; Brown et al., 2001; Stein, 2001). There are also a number of reports that dyslexia is more frequent in males than females, ranging from 1.5:1 to 4.5:1 depending on the study (Wadsworth et al., 1992; Shaywitz et al., 1990; Ansara et al., 1981; Miles et al., 1998) but it is unclear whether this observation is due to selection factors and/or bias. Until further controlled research is carried out the current consensus is that dyslexia occurs in both sexes with equal frequency. (Refer to appendix 3, number 9 and 10 for peer review comments).

The last decade of research has made significant advances in the possible causes of dyslexia, with a possible neurological basis of the disability being

recognised, but unfortunately there is still no answer or agreement on the exact causes of dyslexia. There is however unanimous agreement that problems with phonology are associated with dyslexia but it is becoming increasingly clear that phonology is not the only problem.

4. Identification of Dyslexia

Early detection of dyslexia and other learning difficulties is desirable in order to obtain appropriate help for the student. Identification of dyslexic students is usually made during the first years of primary school when reading and writing problems are found that go beyond the normal starting difficulties.

A formal psychological evaluation is the only method, across all English-speaking countries, that is recommended for diagnosis of dyslexia. (Refer to appendix 3, number 11 and 12 for peer review comments). In practice however, the lack of international agreement on the definition and causes of dyslexia means a differential diagnosis is not possible and the formal evaluation just looks for a number of indicators that may suggest an individual is dyslexic. Also, in the USA and Canada because the definition of dyslexia differs between states and provinces the eligibility criteria differs, which may result in a child not being recognised as having a learning disability just by crossing a state/provincial border. This situation undermines the credibility and integrity of any identification process, in that it assumes that under any of the definitions currently in use that a learning disability is therefore not permanent or intrinsic (Klassen, 2002).

A full formal evaluation would be carried out by trained specialists and involve:

- Social and family history;
- Cognitive testing;
- Educational testing;
- Classroom observation and review of educational data;
- Medical examination; and
- A debrief of observations and recommendations

In practice, due to time and money constraints, such comprehensive testing is very rarely completed and quicker, simpler screening tests are usually administered to detect signs or indicators of dyslexia.

A number of tests have been designed for use in the cognitive testing part of the formal evaluation. These tests can also be administered in isolation but in these cases they are used as a screening tool to identify students 'at risk' of dyslexia, but make no attempt to diagnose dyslexic students. However, it should be noted that identification of at risk students alone will not improve their literacy levels; they also

need to receive appropriate intervention. These cognitive tests determine a student's strengths and weaknesses in a range of areas, indicating possible intervention strategies that target the identified weakness areas. The theories behind these tests have been described in detail in the previous chapter. Evaluation of the research literature shows that some tests are better supported by scientific evidence than others and information about standardisation varies across the variety of tests. Table 1 describes a number of tests that are available but is not intended to be exhaustive. Appendix 1 includes a more exhaustive list of available tests but descriptions are not provided.

It was hoped by researchers that the development of screening tests would allow identification of children at risk of dyslexia before they fail to learn to read, that is by age 6 or younger. Early screening for dyslexia provides a number of clear advantages, but despite excellent research in the area, until recently viable measures have not been available in any English-speaking country. The following sections of this chapter describe two screening tests that have become educationally acceptable in the UK; the Dyslexia Early Screening Test (DEST) and the Cognitive Profiling System (CoPS); and the two screening tests recommended in US Policy and used extensively in North America; (Wechsler Intelligence Test for Children (WISC) and Response to Intervention (RTI).

In the UK the majority of teachers are not fully trained to recognise dyslexia and other learning difficulties, but the Code of Practice (1994) states that teachers are expected to identify all levels of dyslexia and other learning difficulties and put an individual education plan (IEP) into practice immediately. Development of DEST and CoPS, specifically designed to be delivered by personnel largely untrained in psychometric testing, provided a solution to this problem (Fawcett et al., 1998). These screening tools have been translated into a number of different languages and their use in other English-speaking countries is also increasing, and with the introduction of RTI in the Individuals with Disabilities Education Act (IDEA, 2004) in the US, these or similar screening tools will be needed.

4.1 Dyslexia Early Screening Test (DEST)

The DEST is designed to be administered by a teacher in the first term of school and takes about 30 minutes per child. DEST is not intended to replace

Table 1. A selection of tests available to identify dyslexic individuals

Test	Year	Description	Theory	Research
Aston Index (Newton & Thompson, 1982)	1982	Designed for use by classroom teachers. Tests involve 2 levels, L1 for screening children who have been at school 6 months, L 2 for children over 7 years. Test scores are considered to be ‘mental age’ and are compared to example scores for a child’s chronological age supplied in a manual.	Magnocellular	Sutherland and Smith (1991) conclude that the test is rather dated, has limited use for pupils over 11 years and is difficult to interpret. Pumfrey (1985) and McGhee (1996) are critical of information in the manual on the construction, standardisation and validation of the Index.
Bangor Dyslexia Test (Miles, 1997)	1983 1997	Administered as part of a clinical review to pupils over the age of 7. It involves positive indicators of dyslexia through 10 individual tests.	Cerebellar Phonological	The items comprising the test were developed from clinical data using 291 subjects (Miles 1993). The test cannot be considered a psychometric instrument and interpretation depends more on clinical judgement than dyslexia positive test scores.
Children’s Test of Non-word Repetition (Gathercole & Baddeley, 1996)	1996	A test of short term memory using 40 non-words. The test is standardised with children aged between 4 and 8 years	Cerebellar	This test is thought to compliment tests specifically designed to assess phonological processing. Standardised data is reported using 612 children between 4 and 8 years. Studies of reliability show good correlations and validity is demonstrated through 2 small studies (Gathercole et al., 1994; Turner 1995).
Dyslexia Screening Test (DST) and Dyslexia Early Screening Test (DEST) (Nicolson & Fawcett, 1996)	1996 2003	The tests are designed to be administered by a teacher or psychologist and take about 30 minutes.. The DST is normalised for children age 6.5 to 16.5 and the DEST for children age 4.5 to 6.5. Each tests comprises of 10/11 subtests covering a range of tasks. The test yields an overall ‘at risk’ score and a profile of abilities, but do not attempt to identify dyslexia.	Phonological Cerebellar Magnocellular	These tests take into account research evidence from all three theories of dyslexia. The discriminatory power of these tests are however based on the authors own research (Nicolson & Fawcett, 1990, 1995) and independent validation by other authors is currently not yet available.

Table 1. Continued

Test	Year	Description	Theory	Research
Lucid Cognitive Profiling System (CoPS) (Singleton et al., 1996)	1996	This is a computerised standardised assessment system for use by teachers or psychologists with children aged 4 or 5. There are 8 main tests which are presented as games. A graphical profile of results is automatically calculated at the end of the test, and a manual is provided to interpret the profile.	Phonological Cerebellar Magnocellular	The research behind CoPS involved a 5 yr longitudinal study of 400 children. The final tests were selected from 27 on the basis of accuracy and reliability. The tests have all been shown, independently and in combination, to have significant correlations with later literacy development.
Phonological Abilities Test (Muter et al., 1997)	1997	The test contains 4 phonological awareness subtests, a speech rate subtest and a letter knowledge subtest. It is recommended for children aged 5 to 7 years. It is primarily a tool to identify children who are 'at risk' of reading failure due to slower phonological development, not to identify dyslexia.	Phonological	Standardised data for the test is from 826 children aged between 4 and 8 years. Studies of reliability and validity are reported in the manual, and authors advise caution when interpreting results
Phonological Assessment Battery (PhAB) (Frederickson et al., 1997)	1997	The battery of tests is designed for use by psychologists, special education teachers and speech therapists to assess phonological processing. The supplied manual gives information on interpretation and programme planning.	Phonological	Standardised and normalised data for the test was collected from 629 pupils aged 6 to 15 years. Validity of the test was assessed in a study involving 89 children with recognised SLD, with these children achieving lower on the tests than a representative sample of children of the same age group. A study by Fredrickson and Wilson (1996) using rhyme analogy training suggested that the PhAB tests are sensitive to the effects of intervention and could be used in programme evaluation.

Table 1. Continued

Test	Year	Description	Theory	Research
<p>Self-Perception Profile for Learning Disabled Students (Renick & Harter, 1997)</p>	<p>1997</p>	<p>It is a self-report questionnaire designed to assess children's judgements of their competence, worth and esteem in particular areas. The questionnaire consists of 46 items, divided into 10 sections. The results are compared to standardised data supplied in the manual.</p>	<p>NA</p>	<p>Standardised data was collected from 201 SLD pupils and 367 of their peers aged 9 to 13 years. Reliabilities, patterns, means and standard deviations by section and year group are reported, along with guidance on interpretation. Using these profiles for SLD pupils is relatively new but Boetsch et al (1996) report results which show that dyslexic children, compared to controls, perceive themselves as having lower intellectual ability, lower academic competence and lower global self worth. These profiles may be useful in identifying the areas of competence which influence a child's self worth.</p>
<p>Wechsler Intelligence Test for Children (WISC) (Wechsler, 1992, 2004)</p>	<p>1992 2004</p>	<p>This is the most frequently used diagnostic instrument for assessing intelligence for use with children age 6 to 16 years. A student's score in 4 academic tests (ACID) are compared to scores on the other tests which determine cognitive status and potential for learning. The procedure for identifying an ACID profile is outlined in the WISC-III and WISC-IV (Wechsler, 1992, 2004). Children with dyslexia are considered to be those that perform badly on the ACID tests, however, wide scatter and discrepancies are also an important diagnostic sign.</p>	<p>Phonological Cerebellar</p>	<p>Standardised data on each subtest score and IQ scores is based on the scores of 2200 children nationwide (US). Compared to the other tests there is substantial data in the literature on the use of WISC and ACID profiles. Some authors have claimed that the ACID profile is of value in the identification and diagnosis of dyslexia (Vargo et al., 1995). However, the majority of studies criticise the ACID test due to the lack of clear specification of subjects, absence of normal control group, wide age ranges and small sample sizes (Frederickson, 1999; Miller & Walker, 1981; Greenblatt et al., 1991)</p>

Table 1. Continued

Test	Year	Description	Theory	Research
<p>Woodcock Johnson III (WJIII) (Woodcock et al., 2001)</p>	<p>2001</p>	<p>There are two separate but co-normed batteries of tests (Tests of Cognitive Abilities and Tests of Achievement) that measure general intellectual ability, cognitive abilities, scholastic aptitude, oral language and achievement. The tests are designed for administration by psychologists or specially trained teachers and are appropriate for ages 2 to 90+. Test scores are interpreted based on the discrepancies between clusters of tests.</p>	<p>Phonological Cerebellar</p>	<p>Standardised and normalised data for each subtest are based on the scores of 8800 US subjects aged 2 to 90+ years. Normative data are available by month for each age level, and by grade for kindergarten through 12th grade. These tests are relatively new and validity studies have only been carried out by the authors. These validity studies have shown that ability/achievement discrepancies are the best measure for diagnosing learning difficulties with a reliability of 0.8. Whereas, intra-ability variations can be used to determine an individual's strengths and weaknesses.</p>
<p>Response to Intervention (RTI) (Fuchs & Fuchs, 2001)</p>	<p>2001</p>	<p>This is a dynamic form of assessment in which every student in a grade is assessed with a screening tool to identify 'at risk' students. The 'at risks' students are then monitored (by comparison of the students performance with established criteria, which could be national benchmarks, local norms or even classroom norms) through a series of progressively more intensive instructional interventions over extended periods of time. Learners with serious reading difficulties are those whose difficulties are not resolved by the interventions.</p>	<p>Phonological Magnocellular Transactional</p>	<p>RTI is a recent innovation which provides early intervention for students who are at risk for school failure but also to identify students with reading disabilities. The RTI model is being scaled-up based on a body of controlled research, but this body of research is currently small (Fuchs & Fuchs, 2006; O'Connor, 2000; Speece et al., 2003; Vaughn et al., 2003). For this method to be effective the development of valid and reliable assessments for all age levels, teacher training and continued support and monitoring of teachers is required.</p>

Table 1. Continued

Test	Year	Description	Theory	Research
<p>Dynamic Indicators of Basic Early Literacy Skills (DIBELS) (Good & Kaminski, 1998)</p>	<p>1998</p>	<p>DIBELS are a set of individually administered tests that measure early literacy development. They can be administered by a teacher or psychologist and take about 7 minutes per students. DIBELS measures fluency in initial word sounds, letter naming, phoneme segmentation, nonsense words, oral reading, retelling and word use. Each measure is an indicator of early literacy development, and student results assess student development, indicate areas where instructional intervention is required. The tests are designed to be used regularly so student progress and the effectiveness of intervention can be assessed.</p>	<p>Phonological</p>	<p>Each test has been standardised from Kindergarten to Year 3, and the reliability, validity and sensitivity has been investigated in a series of studies (Kaminski & Good, 1996, 1998; Elliott et al., 2001; Good & Jefferson, 1998). Research has confirmed that there are correlations between the results of DIBELS tests and reading ability 1 year later (Good & Jefferson, 1998).Data is collected on an on-going basis, which documents student growth towards class, school, district or national benchmarks. It does not aim to diagnose dyslexia but is a tool to be used to prevent reading difficulties and promote reading success by early intervention and monitoring.</p>

traditional diagnosis, but rather to identify children at risk of failure for a range of reasons, and provide pointers to the need for further assessment. The DEST covers a wide range of skills, including theoretically derived tests of motor skill and speed, as well as tests of phonological skills and memory.

The DEST has been normed using 1000 children. These norms have been calculated for children at six monthly intervals for children from age 4.5 to 6.5 years. Fifty subtests were initially trialled which were narrowed down to ten on the basis of the results giving the strongest indicators of dyslexia, ease to administer, minimising resources and feedback from students and teachers. It involves 11 two-minute subtests and gives a profile of abilities on the key skills (including balance, speed and audition as well as literacy, phonology and memory) and an overall 'at risk' index indicating whether special support regimes should be introduced. It is designed to pick up all developmental learning difficulties, rather than just dyslexia. The subtests measure letter and digit knowledge, naming speed, phonological skill, memory, motor skill, balance, temporal processing and shape copying ability. The results provide a profile of scores on a range of skills which can provide a basis for identifying appropriate support strategies or for referral for further testing by a qualified psychologist.

The validity of DEST was determined by undertaking a longitudinal predictive study where the progress of 97 5 year olds were followed through to the age of 7, so as to identify which of the students initially identified as at-risk turn out to be dyslexic. A false positive rate of 12 % and a false negative rate of 2 % were obtained.

At this stage DEST appears to be a cost-effective tool to identify at risk students. It offers the advantage that it can be administered and assessed by a teacher, takes 30 minutes to administer, involves minimal resources and can be used to develop individual remediation strategies. However, as independent validations by other researchers are only just appearing in the literature (Whiteley et al., 2002) its wide reaching uses have not yet been determined.

4.2 Cognitive Profiling System (CoPS)

CoPS is a computer based assessment which can be used with children aged between 4 and 9 years. As with DEST, CoPS is not intended to replace traditional diagnosis, but rather to identify children's cognitive strengths and weaknesses, which

can give an indication of who is at risk for dyslexia and other learning difficulties. However, the information generated by CoPS is also valuable in enabling teachers to recognise the learning styles of individual children. CoPS is straightforward to administer, and designed to be used by teachers or psychologists, however, the interpretation of the graphical profile of results that is automatically calculated requires expertise in education or psychology.

The research which led to CoPS was to investigate techniques which teachers could use with ease and confidence to identify dyslexia in young children. The computer was chosen to deliver the test because:

- Of its precision, objectivity and flexibility
- Computer based testing requires minimal training of the administrator
- It is attractive and less threatening to children

From 1990-1996 a longitudinal study of almost 400 children from 24 schools was carried out. At the beginning of the study the children were 5 years old. A total of 27 different tests were initially created to assess a wide range of cognitive abilities that are especially important in the early stages of literacy development, and believed to be valid indicators of dyslexia (Singleton & Thomas, 1994). All tests were administered to all the children and over the next 4 years their literacy, numeracy and intellectual development was tracked using a variety of standardised psychological measures. The follow-up data was then used to determine which tests were most effective at predicting dyslexia and other literacy difficulties in children. Eight tests were chosen which gave the most satisfactory results and these involve memory, phonological awareness and auditory discrimination. CoPS was then standardised on over 800 children. The prediction rate of CoPS was found to be 96 %, with a false negative rate of 16.7 % and a false positive rate of 2.3 % (Singleton, 1997).

CoPS is a diagnostic and assessment tool which can be used by teachers working with normal developing children and those who have dyslexia and other learning difficulties. It offers the advantage that it can easily be administered by a teacher, it takes 45 minutes to administer, and it identifies strengths and weaknesses. However, even though minimal teacher training will be required on test administration, interpretation of the results requires expertise in education or educational psychology, which will increase costs and depending on workload, may result in a delay of the results and the start of any required intervention.

4.3 Wechsler Intelligence Test for Children (WISC)

This is the test most commonly used by psychologists worldwide to test a child's IQ and to examine the strengths and weaknesses of their learning. It has been translated and adapted for a number of countries including Spanish, Swedish, French (France and Canada), English (US, Canada, UK) and Italian. Separate norms have been established with each translation. There have been revised versions of WISC and each successive version has renormed the test, refined questions and updated materials to make them more useful in the administration of the test.

Administration and scoring of the WISC requires a competent administrator who can interact and communicate with children of different ages and must know test protocol and specifications. The test takes between 50 and 75 minutes and is divided into two distinct sections:

- Verbal Section- measures how well children are able to express themselves verbally and how well they are able to understand what is being said to them. It includes a scale for information, vocabulary, comprehension, similarities, arithmetic and digit span.
- Performance Section- measures nonverbal areas of being able to perceive spatial relationships related to problem solving, perceptual organisation, speed and visual-motor proficiency. It includes a scale for picture arrangement, picture completion, coding, block design and object assembly.

In addition to verbal and performance IQ scores, verbal comprehension, perceptual organisation, freedom from distractibility and perceptual speed can be measured. These will add to the overall picture of a child's learning ability.

A student's ACID score, from the arithmetic, coding, information and digit span subtests, are compared to scores of the remaining subtests. If scores on all 4 ACID subtests are equal or lower than the lowest score on the other subtests, then the student is considered to have a positive ACID profile.

Some authors have claimed that the ACID profile is of value in the identification and diagnosis of dyslexia (Vargo et al., 1995) but their study confines itself to between group, SLD and control, comparisons and no individual comparison is attempted. So, whilst the incidence of the ACID profile is found to be higher in SLD samples than in random samples of the population, this very small difference is not useful in individual assessment. Similar studies by Prifitera and Dersch (1993)

and Watkins et al. (1997) looking at the incidence rate of the ACID profile in normal and learning disabled samples, found that the ACID profile was greater in the SLD sample, but it was only between 4 and 5 %. Thus, Watkins et al. (1997) appear justified in their conclusion that the ACID profile is a ‘poor diagnostic indicator’ and should not be used for diagnosis of dyslexia.

The empirical consensus is that WISC is best used as a tool to evaluate intelligence and not to diagnose learning disabilities. However, WISC is still widely implemented by clinicians but it tends to be used with other sources of data to contribute information concerning a child’s overall well-being.

There are also extensions to WISC which test educational attainment, these are known as Wechsler Dimension Tests and they focus on a particular dimension of learning. They include:

- The Wechsler Objective Reading Dimensions (WORD)- tests reading, spelling and handwriting skills.
- The Wechsler Objective Language Dimensions (WOLD)- tests listening comprehension, oral expression and written expression.
- The Wechsler Objective Numeric Dimensions (WOND)- tests mathematical reasoning and numeric calculation.

The scores obtained in each of these tests are combined to give the Wechsler Individual Achievement Test (WIAT).

4.4 Response to Intervention (RTI)

The emphasis of RTI is to focus on providing more effective instruction by encouraging earlier intervention for students experiencing difficulty learning to read. The increased momentum for this model in North America is due to practitioners being encouraged to move away from the IQ-discrepancy approach to identifying children with learning disabilities. In the US in 2004, President Bush signed into law the Individuals with Disabilities Education Act (IDEA, 2004). This Act still retains the discrepancy model as its underlying diagnostic indicator of disabilities in reading, but it also introduces the “Response to Intervention (RTI)” method as an alternative approach. The act authorises up to 15 % of IDEA funds to be used to provide services to students before they are identified with a disability.

RTI aims to offer quality literacy instruction in a supportive general education environment, thus reducing the number of students who are inappropriately referred and placed in special education. Although no universally accepted RTI model or approach currently exists, the many possible variations can be conceptualised as elaborations on or modifications to the following three-tiered model (Fuchs & Fuchs, 2001):

- Screening- In the first month of the school year all students are screened to identify those 'at risk' of school failure. To date no specific screening tools have been specifically suggested to identify at-risk students, but the authors believe best practice to include (1) assessing everyone using a brief screening tool that demonstrates diagnostic utility for predicting performance in reading and maths OR (2) taking students who perform below the 25th percentile on the previous years assessment or a more recent assessment, and screen them individually with a diagnostically useful tool (as (1)).
- Implementing Classroom Instruction (Tier 1)- Students receive evidence based high quality instructional and behavioural support in general education implemented by the teacher. The fidelity of implementation is documented.
- Monitoring Responsiveness to Classroom Instruction (Tier 1)- At-risk students are monitored for 8 weeks to identify those students that respond inadequately to general education. Best practice would involve assessing these students every week for 8 weeks using brief monitoring tools in the area of risk (e.g. reading). Adequate Tier 1 response is operationalised using (1) local, national or even classroom normative estimates for weekly improvement OR (2) criterion referenced figures for weekly improvement.
- Implementing a Supplementary Diagnostic Instruction (Tier 2)- The non-responders from Tier 1 receive a further 8 to 12 weeks of supplementary instruction. Special educators/teachers etc collaboratively design a supplementary diagnostic instruction program tailored to the students needs. The instruction may be implemented by the teacher, or more likely a specialist or an aid and would involve Tier 1 non-responders to participate in small-group (no more than 3 students) instruction who share similar strengths and weaknesses. The group is taught at least 3 times per week for 30 minutes within general education.

- Monitoring Responsiveness to Supplementary Diagnostic Instruction (Tier 2)- This would be carried out in the same manner as the responsiveness from Tier 1. Parental feedback is also provided. Continuous progress-monitoring determines the interventions effectiveness and whether any modifications are needed.
- Designation of LD and Special Education Placement (Tier 3)- The non-responsive students from Tier 2, on receipt of parental consent, receive an individualised, comprehensive evaluation to determine eligibility, that rules out mental or behavioural possibilities.

If this process is successfully implemented it is thought to offer a number of advantages over other methods (Vaughn & Fuchs, 2003; Fuchs & Fuchs, 2001):

- Children do not need to wait to fail or fall behind their peers before they are eligible for support;
- It represents a more valid method of LD identification because early intervention will decrease the number of ‘false positives,’ or students given the disability label who are low achievers because of poor instruction;
- It avoids problems with deficit and discrepancy models; and
- It is instructionally grounded.

However, at present the RTI model can only be hypothesised as being able to identify students with reading disabilities and preventing academic failure among all students. Of the small body of research on the RTI model it can be characterised as having two foci: (1) intervention studies investigating the efficacy and delivery of remedial methods and (2) field studies evaluating the RTI process itself. Both areas of RTI research have shown promising results (Gerber et al., 2004; Leafstedt et al., 2004, Linan-Thompson et al., 2003; Fuchs & Fuchs, 2001, 2006; O’Connor, 2000; Speece et al., 2003; Vaughn et al., 2003), but many of the practice based aspects concerning RTI have yet to be determined, leaving many questions to be researched prior to wide-ranging implementation. For example the development of scientifically-based educational practices, valid and reliable assessments for all age levels, the success rate at each level, teacher training and continued support and monitoring of teachers is required. This current lack of scientific evidence in all key areas of the RTI model has resulted in reservations amongst a number of researchers on its

effectiveness (Cunngham & Fitzgerald, 1996; McEneaney et al., 2006). (Refer to appendix 3, number 14 for peer review comments).

The ability to predict which children will have the most serious reading difficulties is still far from perfect, with false positives and false negatives being identified in all identification tests and procedures. Prediction accuracy is found to increase the longer a child is in school, with the prediction of reading disabilities from tests given at the beginning of year 1 being significantly more accurate than the tests administered during preschool (Torgesen, 1998). Thus, to maximise the chances for identification of all at risk students, early identification procedures will need to be carried out with as many children as possible. (Refer to appendix 3, number 13 for peer review comments).

It should be stressed that screening tests do not measure a child's overall performance in reading. The goal of these identification procedures is to quantify the degree of skill a child possesses in a number of areas that have been shown to be a critical foundation for overall reading success, for example phonological awareness and fluency. As all these screening tests take the words out of context they may not be classed as an authentic guide to reading success, but they give a picture of the kinds of skills that are deficient in a child with reading problems and based on these results, the eligibility of special education services can be determined and an intervention plan can be implemented and monitored. However, to obtain a complete picture of overall reading ability it is important to observe the way the child integrates all sources of information about words in text, and this can only be estimated by carefully observing children as they read connected passages. (Refer to appendix 3, number 15 for peer review comments).

5. Intervention and Support

Identifying the most effective instruction and remedial intervention methods for children at risk of developing reading problems and for those who are already struggling is equally complex. Without appropriate teaching and resources, dyslexic learners are at risk of social exclusion, school failure and the inability to find and hold down employment. (Refer to appendix 3, number 16 for peer review comments)

It has been observed in research that early success in acquiring reading skills usually leads to later success in reading, while failing to read before the third or fourth year of schooling may be indicative of life-long reading problems (Juel, 1988). Stanovich (1986) labelled this phenomenon the Matthew effect, describing the mechanisms by which proficient readers continue to build vocabulary and fluency through reading, whereas weak, dysfluent readers tend to avoid reading and read less, thus thwarting their growth in vocabulary, basic word knowledge, and fluency. In terms of improving literacy levels for dyslexic individuals and at risk readers, the Matthew effect tells us that early intervention is much more effective than later intervention or remediation. In the early years of schooling, the gap that separates the students 'at risk' of reading failure and the students who are likely to be successful readers is small (Tunmer et al., 2003). However, without intervention this gap will widen over time, until, by the 4th year of schooling it is nearly insurmountable, as shown in Figure 1.

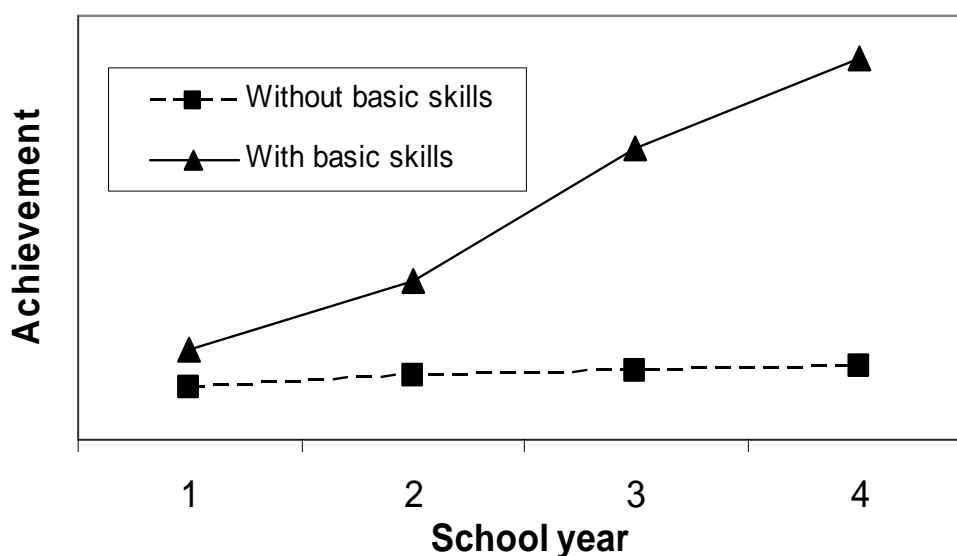


Figure 1. The Matthew Effect in Reading

One of the keys to defeating the Matthew effect, which will have a significant impact on dyslexic readers, is early assessment and identification of appropriate intervention methods. A variety of assessments which could be utilised in the early school years have been described in Chapter 4. However, identification of effective intervention methods for dyslexic readers (and poor readers) is a challenging process because every person with dyslexia is different. (Refer to appendix 3, number 17 for peer review comments). There are many reported interventions available that claim to tackle dyslexia from teaching reading, to programs that focus on balance and coordination through to taking dietary supplements such as omega-3 (Alexander & Slinger-Constant, 2004; Myomancy Treatment Database, date unknown). Table 2 describes a number of commercial intervention programs that have been developed to help dyslexic individuals. This is not an exhaustive list of available interventions, but is thought to give a snapshot of the available interventions that aim to target a variety of dyslexia symptoms and possible causes. Appendix 2 includes a more exhaustive list of available intervention programs but only very brief descriptions are given. It should be kept in mind that commercial intervention programs are not intended to provide an alternative to traditional educational interventions, but are a complimentary option available that may improve dyslexic individual's skills. Table 3 describes a number of traditional educational programs that have been the focus of research studies involving dyslexic or struggling readers.

The US Department of Education (2003) published a guide for identifying educational practices supported by rigorous evidence and this has been used to sort through the myriad of promotional and research claims reported in the literature about the effectiveness of the commercial dyslexia programs and educational teaching areas reported in Tables 2 and 3. The guide stated that to be supported by rigorous evidence an educational research study should:

- Implement a well-designed randomised controlled trial;
- Have a clear description of the intervention, who administered it, who received it, the costs, the sample size and the logic of how the intervention is supposed to affect outcomes;
- Measure outcomes that are valid, and preferably the long-term outcomes of the intervention to assess its effectiveness over time; and
- Report the size of any effects observed and their significance.

Table 2. A selection of commercially available programs available to support dyslexic individuals

Method	Description	Target Cause	Support provider	Evidence
Dore Programme	The initial assessment at a Dore centre tests a range of motor, neurological and cognitive functions. A personal exercise program is then individually tailored. The exercises are simple, carried out at home and take about 5 to 10 minutes twice a day. Every 6 weeks the child returns to the Dore centre for re-evaluation, the program usually takes 9 to 18 months to complete.	Cerebellar deficit	The assessment and exercise program is conducted and devised by trained Dore specialists. The program is administered at home daily by the parents with supervision from the Dore centre.	A number of studies are reported on the website but only one research study is currently available in peer reviewed published literature. From this one study significant improvements in balance, dexterity and eye movement control along with reported improvements in reading (Reynolds et al., 2002), but other researchers have reported flaws in the methodology, design, analysis and interpretation of these results (Alexander & Slinger-Constant, 2004). Thus future methodologically sound studies are encouraged to validate this intervention.
Dyslexia@bay™ system	The student attends a one-off consultation and carries out simple and fun exercises where they are screened for 41 individual thinking skills. An individual learning profile is then drawn up which includes mental and sometimes physical exercises which are designed to activate various parts of the brain. The exercises must be carried out for 28 consecutive days immediately after consultation.	Cerebellar deficit	The initial consultation is with a dyslexia@bay consultant. The exercises are intended for implementation by the student with assistance from a parent.	Support for this method comes from anecdotal reports rather than empirical data. Thus independent methodologically sound studies are needed to give this intervention a scientific basis.

Table 2. Continued

Method	Description	Target Cause	Support provider	Evidence
Davis Method	This is a counselling based approach which includes techniques to address perceptual confusion (orientation counselling), which are used in tandem to reading exercises and a systematic approach to learning letters and words (symbol mastery). The program is delivered by a trained facilitator, one-on-one for 30 hours over 5 consecutive days. After this week, support training is given to the parent/tutor to enable follow up of the program at home.	Disorientation/ Confusion	The first week of the program is carried out by a trained facilitator at a Davis correction centre. Purchase of the book (Davis, 2005) may also enable teachers or parents to implement some of the exercises in other settings.	Most support for this method comes from informal case studies or anecdotal reports rather than empirical data. One study has been reported in the literature (Pfeiffer et al., 2001) that assesses the effect of integrating some of the Davis techniques into a first year school reading curriculum. Compared to a matched control group students who were also taught the Davis techniques showed significantly higher accuracy on tests of basic sight word recognition.
Wilson Reading System	This is a structured 12 step program based on the Orton-Gillingham multisensory approach. Steps 1 to 6 teach the basics of decoding and encoding words, whereas steps 7 to 12 focus on word analysis, vocabulary development, comprehension and metacognition. This program can be taught individually or in small groups for 60 to 90 minutes a day 4 to 5 days a week, and takes 1 to 3 years to complete.	Phonological deficit	The program can be implemented in an educational setting by a teacher who is a Wilson certified instructor.	There is a small body of evidence that supports the ability of the Wilson Reading System to close the gap in reading skills for struggling readers. A study involving analysis of the data collected from Wilson tutors showed statistically significant gains on the Woodcock Reading Mastery Test (Wood, 2002). Also, a study involving 220 learning disabled readers showed significant gains in word attack, comprehension, total reading and spelling (O'Connor & Wilson, 1995). However, the research designs in these studies are weak, so support at this stage must be regarded as tentative.

Table 2. Continued

Method	Description	Target Cause	Support provider	Evidence
Orton-Gillingham Approach	This is a multi-sensory method which uses auditory, visual and kinaesthetic approaches to teach dyslexics to read. The approach teaches phonemic awareness, phoneme/grapheme correspondence, syllables, rules and morphology using a range of multisensory instruction techniques. Informal assessments are carried out and the data collected will drive the instruction for subsequent lessons. Numerous programs have been developed using this approach (Slingerland, Project Read, Alphabetic Phonics, SMT method to name a few).	Phonological deficit and memory problems	One must undergo lengthy and comprehensive training in the Orton-Gillingham approach to be able to create student specific lessons. These can then be employed within the classroom setting.	There are no empirical studies in the research literature that are specific to the Orton-Gillingham approach described in the training materials. However, there are a number of studies of other intervention programs that are based on the Orton-Gillingham approach, but due to these programs containing their own unique features they cannot be used to gauge the effect of the Orton-Gillingham approach to improving reading of dyslexic individuals.
DaisyQuest	This is a software package that offers instruction in phonological awareness, targeting children aged 3 to 7 years. The software uses graphics and stories to engage children in the learning process. Included in the program are tests which once completed will generate statistical reports to assess performance.	Phonological deficit	This could be used in a classroom setting and supervised by a teacher or teacher aid. It could also be used at home and supervised by a parent.	There is limited research in the literature on the effectiveness of DaisyQuest. However from five research studies a review has found that 4 out of the 5 studies have a good evidence base and that it has statistically significant effects on outcomes in the alphabetic domain (US Department of Education, 2006).

Table 2. Continued

Method	Description	Target Cause	Support provider	Evidence
Lindamood-Bell Program	This is a one-on-one individualised sensory-cognitive instruction program. It targets decoding skills through the development of phonemic awareness and symbol imagery; and vocabulary and comprehension through concept imagery. Instruction is either for 1 hour a day for 4-6 months (regular instruction), or 4 hours a day for 6-8 weeks (intensive instruction).	Phonological deficit	This program is implemented by clinicians at Lindamood-Bell centres.	Each year statistics are published on the literacy improvement of students registered with the program, however there are no control group comparisons. Limited independent research has been reported in the literature. A study by Torgesen et al. (1999) comparing different early interventions and a control group has shown that severely at-risk readers could achieve the average range for reading accuracy and fluency after receiving the Lindamood program. However, with older children this program did not reduce the fluency gap (Torgesen et al., 2001).
Fast ForWord	This is a computer based program. It offers an intensive series of interactive exercises using acoustically modified speech. The exercises are aimed at improving auditory processing speed, working memory and phonological awareness. The program involves 10 hours practice a week in 20 minute sessions for 6 to 8 weeks. Results are uploaded daily via the internet to form a database for analysis and comparison of the client's progress to date.	Phonological and Magnocellular (Auditory) deficit	The program is carried out under the supervision of a certified Fast ForWord professional.	This is a controversial intervention because not enough research was carried out before it was marketed. A number of recent studies have been carried out but the results are inconsistent and reveal the need for further research. The study by Agnew et al. (2004) showed improvement on auditory tasks. Comparison of this program with the Lindamood program (Pokorni et al., 2004) demonstrated no significant gains for the children on the Fast ForWord program. In contrast to this Temple et al. (2003) found significant gains in nonword reading, word identification and passage comprehension.

Table 2. Continued

Method	Description	Target Cause	Support provider	Evidence
Occlusion (patching)	The initial assessment measures binocular stability using the Dunlop test. If the child is assessed as having unstable binocular stability the dominant eye is patched for 6 to 9 months.	Magnocellular (Visual) deficit	The initial assessment is carried out at an Orthoptic clinic	A recent study by the creator of the program (Stein et al., 2000) has shown that over a 9 month period significantly more children who had their left eye occluded achieved binocular stability compared to the control group. Also, the occluded children that had achieved binocular stability made nearly double the progress in reading compared to the control group. However, analysis of this work by another researcher has found a number of flaws in the research design, and recommends caution when assessing the claims of this intervention (Fawcett, 2000).

Table 3. A selection of educational programs that have been the focus of research studies involving dyslexic or at-risk readers

Method	Description	Target Cause	Support provider	Evidence
Phonological Awareness Instruction (PA)	This involves understanding the concept of phonemes (the smallest sounds of spoken language, either single letters or sounds). Instruction involves teaching children to focus on and manipulate phonemes in spoken syllables and words.	Phonological deficit	This is implemented by a teacher or computer in an educational setting.	Results from meta-analysis (National Reading Panel, 2000; Fawcett, 2002) has shown that teaching PA to dyslexic children (or poor readers) significantly improve skills such as segmenting, blending and deletion but has a lower impact on reading. But teaching PA significantly improves their reading more than an instruction that lacks attention to PA. PA also improves the spelling of normal readers; however, it is not effective for improving spelling in dyslexic readers. Intervention was found to give a moderate effect after 1 to 4 hours and a high effect for over 5 hours, but effects decline after 20 weeks of intervention. PA training was most effective for at-risk readers, when implemented at pre-school and delivered in a group.
Fluency	This involves teaching a reader to read with speed, accuracy and expression. Reading practice, guided oral reading, or independent silent reading, are generally recognised as an important contributor to fluency.	Cerebellar deficit	This can be implemented in the classroom by teachers, or can be delivered by parents or peer tutors outside the classroom.	Fluent word reading involves the ability to recognise letters, spelling patterns and whole words effortlessly, automatically and visually. Comprehension of text is dependent of fluency. Results from meta-analysis (National Reading Panel, 2000; Fawcett, 2002) showed that guided repeated oral reading improved word recognition, fluency and comprehension. Poor readers were found to need an average of 25 hours intervention. Although intuitive, there is not sufficient evidence to suggest that simply encouraging children to read more has an effect on fluency, accuracy or comprehension.

Table 3. Continued

Method	Description	Target Cause	Support provider	Evidence
Phonics Instruction	This is a set of approaches to the initial teaching of reading and spelling which focus on the relationships between letters and sounds. Phonics instruction may be provided systematically or incidentally. Systematic phonics includes analogy, analytic and synthetic phonics. Analogy phonics teaches students unfamiliar words by analogy to known words; analytic phonics teaches students to analyse sound-letter relationships in previously learned words to avoid pronouncing sounds in isolation; and synthetic phonics teaches students to convert letters into phonemes, followed by blending their sounds to produce a spoken word which the learner should recognise. For writing, this process is reversed. Incidental phonics instruction teaches students phonics as they appear in the text. This is not a planned or structured approach and is based on a natural experience of reading.	Phonological deficit	This is implemented by classroom teachers within a normal classroom setting.	Results from meta-analysis (National Reading Panel, 2000; Fawcett, 2002; Torgerson et al., 2006) indicate that systematic phonics training is associated with better progress in reading accuracy, and that this type of training is more effective than approaches without phonics. Disabled and at-risk readers substantially improved their ability to read words, but due to the lack of studies there is not strong evidence on the impact of phonics instruction on spelling and comprehension. Phonics instruction was most effective when delivered to at-risk preschool children, with the impact on reading for children with known reading difficulties declining as they grow older. Delivering phonics to a whole class, small group or individually does not show any significant differences on the reading ability of at-risk readers. There is currently no evidence that any one form of systematic phonics is more effective than any other, and how much systematic phonics is required.

Table 3. Continued

Method	Description	Target Cause	Support provider	Evidence
Comprehension Instruction	<p>Comprehension is a complex process involving vocabulary development and the ability to think about and extract the information provided in text. Comprehension instruction involves teaching students to use specific cognitive strategies or to reason strategically when they encounter barriers to understanding what they have read.</p>	-	This is implemented by classroom teachers within a normal classroom setting.	Results from meta-analysis (National Reading Panel, 2000; Fawcett, 2002) conclude that there is not enough data to draw firm conclusions about the best way to teach vocabulary and text comprehension. However, preliminary findings involving normal readers suggest that vocabulary instruction should be taught by both direct and indirect methods, with computer programs as support. For poor readers comprehension develops by fluent word reading, vocabulary strength and a combination of strategies for helping the student connect with and think about the text (Swanson & Hoskyn, 2000).
Strategy Instruction (SI)	<p>SI is student centred and teaches students how to learn information and then retrieve that information when needed. The focus of SI is primarily on the rules and the processes/skills required to learn the required concept. SI follows a sequence of events (Swanson, 2001). Teachers state the objective, review the skills necessary for the new information, and present the new information. In addition, teachers question students, provide time for group instruction, independent practice and assessment.</p>	-	This is implemented by classroom teachers within a normal classroom setting.	A number of research studies have been carried out to determine the effectiveness of strategy instruction. Results from a meta-analysis (Swanson & Hoskyn, 2000) have shown that SI has a greater effect on writing achievement than reading achievement for learning disabled students. Across research studies the degree of effectiveness varies but no research studies were found that reported teaching SI had a negative effect on reading or writing achievement. (Refer to appendix 3, number 19 for peer review comments).

Table 3. Continued

Method	Description	Target Cause	Support provider	Evidence
Direct Instruction (DI)	<p>DI is teacher centred and focused on helping students learn basic skills and information. This is a highly structured approach to instruction to accelerate the learning of at-risk students. Students are assessed and placed in instructional groups based on similar performance; this may take place across class or year levels. Instruction using the DI curriculum is fast paced and involves frequent interaction between teachers and students. Tasks are defined clearly and are built up to more complex concepts, using interactive lessons. Frequent assessment in for example reading speed and reading-error ratios and weekly grades are used to regroup students according to performance level.</p>	-	<p>This is implemented by classroom teachers within a normal classroom setting.</p>	<p>There are about 20 studies in the literature that meet the criteria for rigorous scientific testing. Student outcomes were evaluated using a wide range of measures assessing skills in vocabulary, reading, language, and general cognitive abilities. In these studies DI was usually compared with other educational programs. The majority of these studies did not focus on dyslexic or at risk readers, and the results were found to vary significantly from study to study suggesting the effectiveness of DI is limited. Studies carried out focusing on at-risk readers were also varied. Lewis (1982) found that DI students outperformed the control group in 2 out of 8 reading assessments; accuracy and comprehension, and results from a meta-analysis (Swanson & Hoskyn, 2000) of seven research studies showed positive effects of DI instruction. However, Richardson et al. (1978) study found no significant improvements for students in the DI program compared to controls.</p>

Table 3. Continued

Method	Description	Target Cause	Support provider	Evidence
Whole Language	This is a literacy instructional approach which emphasises that children should focus on meaning in reading and expressing meaning in writing. The whole language approach is literature based and reading ability is thought to develop from exposure to text.	-	This is implemented by classroom teachers within a normal classroom setting.	There is evidence in the literature that whole language interventions seem to promote general understandings about reading and writing for normal achieving students (Pressley, 2001). However, there is also evidence that whole language is not very effective in promoting the development of phonological awareness and word recognition skills in at risk students (Pressley, 2001; Stahl et al., 1994)
Reading Recovery (RR)	After a year of classroom instruction the bottom 20 % of students, based on results from the observational survey can be placed into an individually designed RR program to help students with difficulty learning to read and write. The survey consists of 6 assessment tasks including concepts about print, letter identification, book level, word reading, writing vocabulary, and hearing and recording sounds in words. The program provides 30 minute daily lessons, and students are discontinued when their reading level is within the average band for their class, typically 12 to 20 weeks.	Phonological deficit	Specially trained RR teachers.	Considerable research has been conducted demonstrating the success of RR, however the majority of these studies do not meet the criteria for rigorous scientific testing. A recent meta-analysis of the available literature (D'Agostino & Murphy, 2004) showed that both discontinued and non-discontinued RR students achieved higher on all 6 observational survey measures. However, discontinued students scored significantly lower than their peers on external achievement tests, yet the gap had been closed. Non-discontinued students however did not appear to close the gap on their peers. A further study by Schwartz (2005) addressed previous issues of unequal control groups and found that the RR group performed significantly higher than the control group.

Table 3. Continued

Method	Description	Target Cause	Support provider	Evidence
<p>Help One Student To Succeed (HOSTS)</p>	<p>This is a structured mentoring program aimed to support regular classroom instruction. Trained volunteers provide 30 minutes of one-on-one tutoring 4 times a week, using individualised lesson plans designed by a schools HOSTS teacher. Assessment of students strengths in word analysis, vocabulary and comprehension are feed into a nationwide database (US) and generate an individualised educational plan based on local standards and resources.</p>	<p>Phonological and cerebellar deficit</p>	<p>This program is supervised by a specialist reading teacher (HOSTS teacher) and implemented by volunteer tutors within a school setting.</p>	<p>The database is continually growing but some instructional materials and strategies have become dated and do not reflect current research. There is a small body of research that demonstrates the effectiveness of HOSTS, however, there have been no control groups (Burns et al., 2004). Currently, a two-year study is underway on the effectiveness of HOSTS and a control group is being employed.</p>

As shown in Table 2 very few commercial dyslexia intervention programs have had rigorous scientific testing to prove they work so selecting a treatment amongst all the different claims can be difficult. To add to this difficulty, even among the effective treatments, a particular treatment may work on one person but not another. (Refer to appendix 3, number 18 for peer review comments). Table 3 shows a number of educational programs that have been the focus of research to improve the reading ability of dyslexic individuals, however, the majority of the literature supporting an intervention was not considered because it falls short of the stringent criteria used in the meta-analysis studies. Emerging findings from some of the less methodologically sound studies that display positive and negative impacts on reading achievement include (National Reading Panel, 2000; Pressley, 2001; Swanson & Hoskyn, 2000):

- Instruction at home;
- Television;
- Computer technology;
- Community resources; and
- Language of instruction.

If all this evidence on improving the reading ability of dyslexic individuals is taken into consideration some of the following key questions are able to be answered:

- What types of prevention or intervention treatment will be most effective?
- What level of intensity is most effective? Including frequency and instructor to student ratio.
- How many hours are needed to complete the intervention and what is the optimal duration of treatment?
- Are the gains and skills maintained after the intervention has ended?
- What therapist or teacher skills are needed?
- In what education context can the intervention be implemented?

It has been identified that starting school motivated to read and with the prerequisite language and early literacy skills is highly important, thus all children, especially those at risk of reading difficulties should have access to early childhood environments. These environments should promote language and literacy growth and address a variety of skills that have been identified as predictors of later reading

achievement. An ideal preschool instruction would be designed to stimulate verbal interaction to enrich children's vocabularies, to encourage talk about books, to provide practice with the sound structure of words, to develop knowledge about print, including the production and recognition of letters and to generate familiarity with the basic purposes and mechanisms of reading.

After a degree of exposure to print and early reading skills the accuracy of identifying at risk students increases. There is strong evidence in the research literature that early identification and thus early intervention has a significant impact on later reading ability. Even though timing issues with regard to preventive instruction have not been completely resolved by research, it has been shown that instruction in phonological awareness and phonics to at risk readers at an early age reduces the prevalence of dyslexia compared to at risk individuals who did not receive training (Schneider et al., 1999; Borstrom & Elbro, 1997; National Reading Panel, 2000; Torgerson et al., 2006). Critical word reading skills of most at risk children are maintained at roughly average levels if this type of instruction is provided sometime in preschool or year 1. However, there will be a number of children with severe difficulties who will demand higher levels of resources, but the numbers of these children will be significantly reduced by early intervention, thus ensuring that support and services are concentrated on those children with entrenched difficulties.

To assist these children the strengths and weaknesses of the individual need to be assessed prior to selecting a program, so an intervention can be implemented that targets the individuals' weaknesses but utilises their strengths (Given & Reid, 1999; Torgesen, 2000). Greater intensity and duration of instruction will be required because of the increased explicitness of instruction for children who are at risk for reading failure (Torgesen, 2002). As even the best teachers can only make minimal adjustments in whole-class or small-group settings, one-on-one tutoring and professional development are likely to be critical components of an educational program designed to target students with severe difficulties. Thus an important challenge is to make sure that teachers understand the course of literacy development and have access to a wide range of instructional techniques, materials and the knowledge required to use them. Research has also shown that computer technology has great potential for improving reading achievement, with promising

approaches for promoting word recognition, vocabulary development and comprehension being developed.

A critical area not yet discussed, is the importance of an intervention not only being effective at improving reading ability but its cost effectiveness. Many of the policy arguments among competing approaches centre on cost effectiveness, so it is critical that these kinds of issues be explored. There is very little research of this type in the literature because cost-effectiveness research requires a comparison between at least two interventions trying to accomplish similar goals with samples from the same population of students (Hummel-Rossi & Ashdown, 2002). Fawcett (2002) has carried out a very simple cost effectiveness calculation on a number of phonological awareness and phonics intervention studies. These calculations show that any intervention is more cost effective with younger students that are at risk of reading difficulties, compared to older students that have been identified with a reading disability; stressing the need for early preventive programs. It was also found that interventions of 25 hours or more tended to be very poor in terms of cost effectiveness, as the likelihood of a successful outcome after this time is reduced, especially for older children with known disabilities.

A recent UK report by the KPMG Foundation (2006) reviewed the long term consequences of literacy difficulties for individuals and for society. This report encompasses all literacy difficulties, and thus is also applicable to literacy difficulties that are a result of dyslexia. In this report the costs of providing early intervention to tackle literacy difficulties was estimated. In this calculation they found that the costs associated with literacy difficulties were linked to special educational provision, to truancy, exclusion from school, reduced employment opportunities, increased health risks and increased risk of involvement in the criminal justice system. Costs were attached to each of these risks and summed over the life course of an individual up to the age of 37.

With early intervention the number of children leaving primary school with very poor literacy skills will be substantially reduced, and this in turn will reduce the costs associated with the risks above. Their calculations were based on evidence from utilising Reading Recovery as the early intervention, which is considered to be a costly intervention. Their calculations assumed that Reading Recovery would effectively lift 79 % of children who received it out of literacy failure. The calculated savings that would be made up to the age of 37 as a result of providing

Reading Recovery at the age of six to approximately 40,000 pupils per year who currently leave primary school with low literacy skills as about £1.5 billion.

Over the last 15 to 20 years there has been a great deal of research focused on finding the most effective methods for treating dyslexia, in particular, looking at the effect of specific interventions on reading skill. Even though dyslexics have a similar problem, namely, reading difficulty, they show varying characteristics (Chapter 3) and the demands of reading and the required skills can be quite different. A variety of interventions have been designed to improve the specific skills needed for normal reading development, but it should be acknowledged that when considering a specific intervention program it may well lead to improvements in the area that the training has focused on, but it is much more difficult to ensure that this relates to overall reading skill.

Whatever interventions are employed it should be stressed that there are no quick fixes, and even effective reading interventions are unlikely to be permanent fixes for dyslexic children. The impact of the reading intervention is typically most apparent immediately after it is provided with the advantage fading over time (Hiebert & Taylor, 2000). Thus cognitive interventions can get students on track, but for the dyslexic student to stay on track more will be required that changes to match the developmental demands on the dyslexic individual (Pressley, 2001).

Methodologically sound studies and recent advances in the knowledge of the reading process have assisted the development of a number of tools to help the majority of students, including those with learning disabilities, to learn to read at the level required to function as effective individuals. The challenge is to put this knowledge in the hands of policymakers, teachers, parents and school administrators so that thousands of students who otherwise would fail to learn to read will gain access to this important skill.

6. Long-Term Prospects of Dyslexics

Reading is the gateway to learning. The ability to understand and use written language has always been a prerequisite to the efficient acquisition of knowledge, and it is becoming increasingly important in today's information society. Children who do not learn to read today can expect to live on the margins of society in every way. However, with great effort most individuals with dyslexia do learn to read, but for these individuals reading never becomes an automatic process as happens with non-dyslexic readers.

From the research presented in Chapter 5 it has been found that if at risk or dyslexic readers are given appropriate instruction in preschool or during the first year of schooling they will have significantly fewer problems in learning to read at grade level than will children not recognised until their third year of schooling. Unfortunately, many children are not recognised to have dyslexia or given appropriate instruction this early on, and of these children who are poor readers in their third year of schooling, about 74 % of them will remain poor readers in the ninth year of schooling and into adulthood (Narayana & Xiong, 2003). However, it is never too late for individuals with dyslexia to learn to read and use other language skills better.

Whilst there is accumulating evidence to guide interventions in children, the kinds of rigorous studies to determine the most effective interventions for adolescents and adults are just underway. The same elements identified to teach children can also be used for older individuals; however the major issue is how to implement such programs to these older age groups. Adult and teenage intervention programs can be highly successful partly because, once they have acknowledged they need help they are usually highly motivated to succeed (Vellutino et al., 2004). It is found that although intensive, evidence based remedial interventions can markedly improve reading accuracy in older, reading disabled or dyslexic individuals; they have been significantly less effective in closing the fluency gap due to the presence of the Matthew effect (Alexander & Slinger-Constant, 2004).

Like children, adolescents and adults with dyslexia will have an individual profile of strengths and weaknesses; however, they will also have developed a range of compensatory strategies to try to overcome their weaknesses. Such compensatory strategies may include relying heavily on long-term memory, which

may involve colour, pattern or involve mnemonics that relate to personal association, or the use of a holistic or global learning approach. Some of these strategies may be helpful, but others may need to be unlearned in order for these adolescents or adults to make progress (Department of Education and Skills, 2004a).

As mentioned previously appropriate implementation of scientifically based instruction programs to young at risk or dyslexic children will make reading possible. However, a common lasting symptom in adolescence and adulthood is a more or less profound spelling impairment (Habib, 2000), which will persist as a permanent hallmark of the disorder (and stands as a possible indicator of retrospective diagnosis of dyslexia in adults).

A number of research studies confirm that children and adults with reading difficulties have an enhanced likelihood of associated emotional and social difficulties (Lindsay & Dockrell, 2000; Hales, 2001; KPMG Foundation, 2006). As dyslexic children grow up their emotional needs become just as important as their academic development (Hales, 2001). These emotional and social problems may be associated with or secondary to the reading difficulties (Esser & Schmidt, 1994; Hales, 2001).

Emotional problems begin to manifest themselves when dyslexic individuals fall behind in their early reading ability. Children who repeatedly experience failure in reading may become demoralised. This influences their self-esteem and may cause them to approach future learning tasks in negative, passive and inefficient ways (Chapman & Tunmer, 1997, 2003; Chapman et al., 2000). Thus, over the years frustration mounts as classmates surpass the dyslexic student in reading skills.

The problems with social relationships may result because (Ryan, 1994):

- Dyslexic children may be physically or mentally immature compared to their peers;
- Social immaturity may make them uncomfortable in social situations;
- Many dyslexics have difficulty reading social cues; and
- Dyslexia often affects oral language functioning.

To overcome a lot of these feelings the dyslexic child is likely to be more active and misbehave to cover up these problems. Between 30 and 70 % of students with dyslexia also experience symptoms of Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD), depending on the setting and

how ADHD is defined (Fletcher et al., 1999). This association is found to be stronger for inattention than for hyperactivity.

Studies have shown that young at risk or dyslexic children have similar levels of self-esteem as normal children. As these children grow older, without effective instruction and support to make improvements in reading, their self-esteem is found to decrease (Hales, 2001; Ryan, 1994). This decrease in self-esteem is also accompanied by an increase in tension, apprehension and anxiety. Researchers suggest that these feelings develop by the age of ten, and after this age it becomes extremely difficult to help the child develop a positive self-image (Ryan, 1994). These findings indicate that early intervention may also have an important impact on the self esteem of dyslexic students. However, it should be stressed that there is no evidence that enhancing someone's self-esteem is a solution to difficulties engendered by academic failure (Muijs, 1997).

Over the last decade there has been significant research studies looking at the relationship between dyslexia and offending. This is a complex and contentious subject, and it is argued that dyslexia, particularly if undiagnosed or not properly addressed, increases the likelihood of educational failure, personal frustration, low self-esteem and social exclusion, resulting in a greater risk of offending. Many studies support this hypothesis with higher incidences of dyslexia reported among offenders than in the general population (British Dyslexia Association, 2005; Kirk & Reid, 2001; Alm & Anderson, 1997). However, other studies have refuted this connection arguing that rates of dyslexia are no higher among offenders than they are in the general population, and the increase of observed cases of dyslexia are actually ordinary poor readers (Rice, 1999). Nevertheless, it can be seen that there may be a link between literacy skills and youth offending, suggesting that reading difficulties need to be addressed as early as possible to reduce such offending.

It should also be noted that students who do not have English as their first language or that are from families with low incomes are not as often diagnosed with dyslexia (Velluntino et al., 2004). More of these students are subject to emotional and psychological impairment, socioeconomic disadvantage, racial and cultural biases, poorly funded schools and relatively inexperienced teachers which are thought to be the reason for their reading difficulties. Identifying dyslexia in these individuals is complicated by the fact that, without culturally and linguistically appropriate assessment tools, it is difficult to determine whether limited language

ability in English is interfering with normal reading or masking the reading disability. However, dyslexia can present itself in any individual, whatever their background.

If at risk or dyslexic readers are not identified and given appropriate support it may keep a child from reaching the level of achievement they are capable of. The consequences are that they will continue to fail and this in turn may produce social and emotional problems. Unfortunately teachers remain unprepared to address individual differences in many academic skills, but particularly reading. However, teachers cannot be expected to know what they have not been taught. Specifically current university-based teacher preparation programs have been found to be inadequate for preparing teachers to address reading difficulties and other types of learning disabilities (LD online, 2006).

Once students are identified as at risk or dyslexic, they will require specific intervention and ongoing support so they are not further hindered in their learning. Owing to the dynamic course of language development and the changes in language demands over time, even after a child has demonstrated a substantial response to treatment, their subsequent progress should be carefully tracked to ensure optimal progress toward the development of functional reading and written language skills (Alexander & Slinger-Constant, 2004). Research on the improvements of students who had early intervention compared to remediation at an older age have shown bigger gains in reading accuracy and fluency, it is easier for them to catch up with their peers, and the long-term cost to educate these children is lower. With appropriate instruction, older children still exhibit gains in reading accuracy, however the fluency gap still exists and they tend to require longer and more intensive instruction.

Research is also clear that in the education and literacy development of dyslexic individuals we do not lose sight of the personal problems dyslexic individuals may meet in society. The emotional response of the dyslexic child will become more significant with age and without this recognition it is possible that the gains made to treat the dyslexia will diminish if adequate support to assist the dyslexic individual is not offered. (Refer to appendix 3, number 20 for peer review comments).

7. Language and Dyslexia

Most researchers working in the field of dyslexia come from English speaking countries and therefore most studies are conducted with English speakers and concern English language acquisition or English dyslexics. However, recently there has been an increase in the number of studies in non-English speaking countries (Goulandris, 2003; Abu-Rabia et al., 2003; Yamada & Banks, 1994; Shu et al., 2006) and cross-language differences (Goulandris, 2003; Landerl & Wimmer, 2000; Ziegler et al., 2003). In the early 1990s the incidence of dyslexia in the USA and UK was reported to be approximately 10 % of the population, whereas Germany reported 5 to 7 %, Italy approximately 3 % and just 1 % of the population of Japan was reported as dyslexic. The variation in reported incidences of dyslexia across countries was the initial impetus behind these studies as it suggested that there may be a relationship between language and dyslexia. Even though the incidences of dyslexia across all countries are now reported to be similar, research has not confirmed whether dyslexia is the same phenomenon across different languages.

7.1 The Impact of Orthographic Consistency on Dyslexia

A language with a consistent orthography has almost one to one correspondence of phonemes and graphemes. Contrary to this, a language with an inconsistent orthography has no regular correspondence of phonemes and graphemes. In this case the same grapheme can be pronounced in many different ways and the same phoneme corresponds to many different graphemes. The orthographic consistency of a number of European alphabetic languages is shown in Table 4. It is thought that the more inconsistent the orthography of a language the more difficult it is for a dyslexic individual to learn to read that language. English has a deep orthography in which the relationships between letters and sounds are inconsistent and many exceptions are permitted. As such English presents a significantly greater challenge to the beginning reader than other more regular alphabetic systems.

A problem with cross-language comparison studies is that it is quite difficult to control for socio-cultural differences across languages. For example there may be differences in school systems, curricula, teaching methods and demographic

distributions. A recent study involving 14 European countries developed a matched set of items of simple real words and non-words (Seymour et al., 2003). These items were given to children from each country during their first year of reading instruction. The data from this study have been reproduced and are shown in Table 5. Children learning to read in orthographic consistent languages (Finnish, Greek, German, Italian and Spanish) showed very high accuracy in both real word and non-word reading. As the consistency of the languages' is reduced children's performance on the reading tasks decreased. The poor performance of English speaking children is inline with the inconsistency of English in reading and spelling. These dramatic differences in reading accuracy across orthographies were mirrored by differences in reading speed.

Table 4. Consistency of a number of European languages relative to orthographic depth and syllabic complexity⁵

		Orthographic depth				
		Shallow			Deep	
Syllabic structure	Simple	Finnish	Greek Italian Spanish	Portuguese	French	
	Complex		German Norwegian Icelandic	Dutch Swedish	Danish	English

Table 5. Percentage of correct responses of real and non-word reading at the end of the first year of reading instruction in 14 European languages⁴

Language	% correct real words	% correct non-words
Finnish	98	95
German	98	94
Greek	98	92
Austrian	97	92
Italian	95	89
Spanish	95	89
Swedish	95	88
Dutch	95	82
Icelandic	94	86
Norwegian	92	91
French	79	85
Portuguese	73	77
Danish	71	54
English	34	29

⁵ Reproduced from Seymour et al., 2003

From this and several other studies it has been shown that the developmental progress of children learning to read in more consistent orthographies such as German or Italian is generally faster than that of children learning English (Harris & Hatano, 1999; Ziegler & Goswami, 2005). Such children also show correspondingly faster development of phonological awareness (Cossu, 1999). In fact, phonological awareness deficits in consistent orthographies can usually only be detected early in development, with this deficit rarely found in adult readers. However, whatever the orthography, dyslexic readers are found to be equally impaired relative to control subjects from their own country on reading and phonological tasks. Thus, the core phonological deficits of dyslexia are harder to detect in children who have learned to read in consistent orthographies. It has been found that in such languages, impairments can be identified most clearly on tasks that require implicit phonological processing, such as those evaluating verbal short-term memory, rapid naming and visual-verbal paired associate learning (Wimmer et al., 1998), rather than on tests evaluating explicit phonological processing and phonological decoding.

Cross-linguistic studies that directly compare dyslexia in English (where there has been a considerable research) and dyslexia in other languages are still comparatively rare (Ziegler & Goswami, 2003; Ziegler et al., 2003; Landerl & Wimmer, 2000; Helmuth, 2001). From this research the current results show that reading accuracy is a minor problem for dyslexics of transparent orthographies, whereas reading speed (automatisation) is a core symptom of the reading impairment (Tressoldi et al., 2001; Frith et al., 1998; Wimmer et al., 1998). For example German speaking dyslexic individuals can read long unfamiliar words and non-words as well as their peers (Frith et al., 1998) but the fluency of their reading is much slower (Wimmer et al., 1998).

Another study comparing dyslexic individuals and normal controls (matched for age, IQ and education) from England, France and Italy showed that the dyslexic subjects in all three countries showed similar cognitive deficits and exhibited equally poor performance in comparison to controls from their own country (Helmuth, 2001). English, French and Italian dyslexics performed equally poorly in short-term memory and phonological tasks, however, the Italian dyslexics scored higher on the reading tests than the English and French dyslexics. It was deduced that even though Italian dyslexics read more accurately than French or English

dyslexics, they still exhibited slow and effortful phonological recoding; supporting the idea that dyslexia is associated with a phonological deficit. Thus, the difference in the prevalence of dyslexia among different countries may be attributed to language.

7.2 The Impact of Alphabetic and Logographic Language Systems on Dyslexia

Early belief was that dyslexia was only a problem for western people. Early observations and surveys reported very low incidences of dyslexia among populations which use logographic language systems, however, nowadays the occurrence of dyslexia in these languages is known to be a lot higher than initially thought (Ho et al., 2004).

It used to be argued that reading problems in countries that use logographic language systems were virtually non-existent because their written symbol language is easier than alphabetic languages. Writing systems in non-alphabetic languages contain a large number of visual symbols or characters that represent units of meaning (morphemes) rather than phonemes as in an alphabetic language. The task of learning to read is therefore a considerable feat for children using non-alphabetic languages as they must learn literally hundreds of visually complex characters. For example Japanese Kanji ideograms consist of 1850 characters, and there are two Kana syllabaries which, like the alphabet, use symbols to represent sounds; and each Kana syllabary has 46 basic letters compared to our 26. Thus it is not surprising that it has been reported that visual skills predict reading ability in logographic languages better than they predict reading ability in alphabetic languages (Ho & Bryant, 1997).

Logographic language systems also require phonological decoding skills; however, the way in which the phonological information is available differs from alphabetic systems (Ho & Bryant, 1997). In logographic languages the graphic information is available first in the identification of the character, however, semantic information only becomes available when phonological information is available, and in logographic languages the phonology of characters has to be learnt as a whole (Ziegler, 2005). This means that phonological information is still required but at a later stage.

The early belief about the low prevalence of dyslexia among logographic language communities has meant that research is rather limited. It has only been within the last decade that dyslexia has been acknowledged to exist in countries which use logographic language systems. Initial research studies focused on identifying the occurrence of dyslexia in these language systems but current research focuses on the manifestations of dyslexia in these languages (Ho et al., 2004; Yamada & Banks, 1994).

From the few studies reported in the literature varying conclusions have been drawn. Studies of children in Beijing, Hong Kong and Taiwan have shown that phonological awareness is a precursor to normal reading and writing in Chinese and can lead to dyslexia in Chinese (Chan & Siegel, 2001; Ho & Bryant, 1997; Huang & Hanley, 1994; Siok & Fletcher, 2001). The studies by Ho and Lai (1999) and Ho et al. (2002) evaluated the visual processing, phonological processing and rapid naming levels of dyslexic Chinese children. These studies indicated that rapid naming deficits were the most dominant type of cognitive deficit in Chinese children. However, the dyslexic children also performed worse than controls on a variety of phonological processing tasks and the children with severe reading and writing problems were found to have multiple deficits. With the level of research presently in the literature there is tentative support for the idea that dyslexia in children who learn to read and write logographic languages is associated with multiple deficits.

Cross-linguistic research studies that focus on the differences between alphabetic and logographic language systems and their impact on reading acquisition are at an early stage. A number of studies have looked at the impact for normal readers but this has not yet been progressed to look at dyslexic readers (Huang & Hanley, 1994). The prevalence of such studies has been hindered by difficulties equating diagnostic criteria across languages.

A case study has been reported on an English-Japanese bilingual boy with monolingual dyslexia (Wydell & Butterworth, 1999). This case study reports that the boys reading and writing difficulties are limited to English only. It was found that his performance in various reading and writing tasks in English, as well as tasks involving phonological processing was very poor. The authors hypothesised that any language where orthography-to-phonology mapping is transparent or even opaque or any language whose orthographic unit representing sound is coarse

should not produce a high level of phonological dyslexia. A follow up study confirmed that his deficit in reading English persisted with time (Wydell & Kondo, 2003). However, due to the paucity of large, rigorous cross-linguistic research studies it is not possible at this time to draw conclusions on the impact of alphabetic and logographic language systems on dyslexia.

Evidence from the literature suggests that the differences in the prevalence of dyslexia in English-speaking countries compared to other more consistent alphabetic languages and logographic languages are much smaller than originally thought. The strongest consensus in the literature at present is that although manifestations of dyslexia differ by language, the underlying causes of dyslexia are universal but the core deficit may differ with orthographic consistency. (Refer to appendix 3, number 21 for peer review comments).

8. Conclusions

Over the years a large amount research on dyslexia has been undertaken but how these findings fit together to form an overall picture still remains elusive. Amongst the English speaking countries there is disagreement on the definition of dyslexia and thus its nature and causes. However, over the last decade the scientific research on dyslexia has made significant advances, and for the first time these scientifically based results have informed educational policy changes in some English speaking countries.

Research evidence has revealed the existence of several subtypes of dyslexia; however, the research strongly suggests that the underlying causes of dyslexia amongst English-speakers are phonological deficits. Phonological awareness has also been found to be strongly predictive of reading and spelling acquisition, where a large number of studies have shown that good phonological awareness skills characterise good readers, whereas poor phonological awareness skills characterise poor readers. All this evidence has meant that the presence of some kind of phonological deficit in dyslexics has gained wide acceptance, and a number of international definitions have been modified to incorporate this finding.

Psychometric approaches to assessing the origin of a child's reading difficulty typically provide no direction for educational or remedial planning. This occurs because such approaches tend to focus on cognitive and biological rather than the manifest causes of a child's reading disability, and also because the clinicians performing such assessments have limited expertise in remedial planning. Recently, this has resulted in a shift in thinking that the clinician would more profitably select psychometric tests that have demonstrated validity for assessing strengths and weaknesses in reading subskills. As the dyslexia population does have various subtypes and is therefore heterogeneous in characteristics and problems, the same educational plan is often not universally applicable. The different subtypes of dyslexia are likely to exhibit different responses to treatment that focus on training different cognitive skills, thus the purpose of assessing strengths and weaknesses in reading subskills is to help educators to develop an appropriate educational plan tailored to the child's individualised needs. A first attempt to this would entail well-balanced and individualised remedial intervention that would build upon a child's existing knowledge base. The evidence suggests

that a child's response to this type of intervention would provide guidance as to their long-term instructional needs, regardless of the origin of their reading difficulties.

It has been found that the expense of creating a sense of failure in children, and of providing for individual treatment within the educational system can be reduced by early detection of difficulties achieved by monitoring at the earliest stages of learning. After detection of reading difficulties, teaching efforts must immediately be intensified and individualised to establish fundamental skills. Even though timing issues with regard to preventive instruction have not been completely resolved by research, it has been shown that instruction in phonological awareness and phonics at an early age reduces the prevalence of dyslexia compared to individuals who did not receive training. Also, the improvements of students who had early intervention compared to remediation at an older age have shown bigger gains in reading accuracy and fluency, it is easier for them to catch up with their peers, and the long-term cost to educate these children is lower. However, with appropriate instruction, older children still exhibit gains in reading accuracy, but a fluency gap still exists and they tend to require longer and more intensive instruction.

Methodologically sound research studies and recent advances in the knowledge of the reading process have assisted in the development of a number of tools to help the majority of students, including dyslexic individuals, to learn to read at the level required to function as effective individuals. However, there are no quick fixes for these students and they will require specific intervention and ongoing support to match the changes in language demands over time. It is also clear that in the education and literacy development of dyslexic individuals we do not lose sight of the personal problems they may encounter in society. To see the impact of these research findings at improving literacy levels of New Zealand dyslexic students involves designing and undertaking rigorous research studies that assess the effectiveness of these international findings in a New Zealand setting. The knowledge gained from these studies would then need to be put into the hands of policymakers, teachers, parents and school administrators, so that thousands of students who otherwise would fail to learn to read will gain access to this important skill. (Refer to appendix 3, number 22 for peer review comments).

9. References

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APPENDIX 1-other tests available to identify dyslexic individuals

- Abecedarian Reading Assessment (Wren & Watts, 2002)
- ACER Tests of Basic Skills (ACER, 1997)
- BAS = British Ability Scale (Elliot, Murray & Pearson, 1979, 1983)
- Boder Test of Reading-Spelling Patterns (Boder & Jerrico, 1982)
- CELF = Clinical Evaluation of Language Fundamentals (Semel, Secord & Wiig, 1995)
- CFT = Culture Fair Intelligence Test (Weiss & Osterland, 1980)
- CTOPP = Comprehensive Test of Phonological Processing (Wagner, Torgesen & Rashotte, 1999)
- D-KEFS = Delis-Kaplan Executive Function System (Delis, Kaplan & Kramer, 2003)
- GMRT = Gates-MacGinitie Reading Tests (MacGintie, MacGintie, maria & Dreyer, 2000)
- GORT = Gray Oral Reading Tests. (Wiederholt & Bryant, 1992)
- Graded Nonword Reading Test (Snowling, Stothard & McClean, 1996)
- LAC = Lindamood Auditory Conceptualisation Test (Lindamood & Lindamood, 1971)
- Neale Analysis of Reading Ability (Neale, 1999)
- PAL = Process Assessment of the Learner Test Battery for Reading and Writing (Berninger, 2001)
- PIAT = Peabody Individual Achievement Test (Dunn & Markwardt, 1970)
- PIPS = Performance Indicators in Primary Schools
- RAS = Rapid Automatic Switching (Wolf, 1986; Wolf & Biddle, 1994)
- (SGWRT) = Schonell Graded Word Reading Test (Schonell, 1945)
- TOWRE = Test of Word Reading Efficiency (Torgesen, Wagner & Rashotte, 1999)
- Wilkins Rate of Reading Test (Wilkins, Jeanes, Pumfrey & Laskier, 1996)
- WJ-R = Woodcock-Johnson Psycho-Educational Battery-Revised (Woodcock & Johnson, 1990)
- WIAT = Wechsler Individual Achievement Test (The Psychological Corporation, 2001)

- Wilkins Rate of Reading Test (Wilkins, Jeanes, Pumfrey & Laskier, 1996)
- WOLF RAN = Rapid Automatic Naming (Wolf, Bally & Morris, 1986; Wolf & Biddle, 1994)
- WRAT = Wide Range Achievement Tests. (Wilkinson, 1993)
- WRMT = Woodcock Reading Mastery Test-Revised (Woodcock, 1987)

APPENDIX 2-other commercial intervention programs

- Dynamic Listening System-uses specific sounds frequencies and patterns to address a root cause of learning difficulties
- Sound Therapy International-music to recharge the brain
- Cook Vision Therapy-teaching co-ordination between the eyes, and with your hands, body and brain.
- Alphabetic Phonics- This is a basic language training program that teaches phonics and the structure of language to individuals or small groups.
- Slingerland Approach- is a structured, sequential, simultaneous, multi-sensory teaching approach, designed to help dyslexic students with speaking, reading, writing, and spelling.
- Sondag System- A multi-sensory structured phonics reading program based on the Orton-Gillingham approach.
- Phono-Graphix- is a way of teaching the English sound system to readers.
- Earobics- It systematically teaches phonological awareness, listening and introductory phonics skills required for learning to read and spell.
- Coloured Lenses-remove problems associated with visual dyslexia making words stable, uniform and in focus.
- Go Phonics- is a systematic, multi-sensory phonics program that teaches beginning reading skills.
- Balametrics- has products and therapies that use balance as the central component to address brain-processing and sensory disorders.

APPENDIX 3-summary of issues raised during peer review process

This dyslexia literature review has been peer reviewed by James Chapman and Bill Tunmer from the College of Education at Massey University, Palmerston North. The purpose of the peer review process was to provide feedback on the literature review in respect of the methodology, structure and comprehensiveness of the review; strengths of the review and/or any obvious gaps in terms of the literature related to dyslexia; and the usefulness of the review and suggestions for increasing its usefulness through links to other work.

In light of the peer review feedback it was decided not to make changes to the body of the text but to refer the reader to the peer review comments. The main body of text has been referenced to the following peer review comments:

- 1) In general the methodology used in the review was sound. A search for relevant articles was carried out using a number of databases and research web pages and a combination of key words. Although rigorous criteria were used in the selection of articles describing research studies of intervention programs, the criteria were relaxed for a number of studies “to ensure a reasonable pool of studies to consider”. However, the evidence in support of most of the commercially available programs presented in Table 2 is very poor (e.g. Dore program, Dyslexia@bayTM system, Davis Method, Wilson Reading System, Fast ForWord, Occlusion).
- 2) An alternative structure for reviewing the literature on dyslexia would have been to consider research relating to the three key questions about dyslexia (what is it, what causes it, and what can be done about it?).
- 3) The review probably would have benefited from direct communication with active reading disabilities researchers who would have provided the author an “insider’s view” of current trends and recent developments in dyslexia research.
- 4) An important aspect of the literature on international definitions that was not fully developed by the author concerns the movement towards defining dyslexia as inadequate response to instruction.
- 5) There are several major shortcomings in this section of the background paper which stem largely from the failure of distinguishing between proximal and distal causes of dyslexia, from conflating subtypes with

different postulated causes, and from not adequately distinguishing between structural and processing differences

- 6) The author correctly defines reading “as the process of extracting and constructing meaning from written text”. She then lists 15 “characteristics” of dyslexia but without first noting that there are two major proximal causes of reading comprehension difficulties. Given that the child’s fundamental task of learning to read is to discover how print maps onto their existing spoken language, the process of learning to derive meaning from print can be adversely affected in one of two ways, or both: the child’s spoken language system may be deficient in various ways, or the process by which print is connected to the child’s spoken language system may be defective. These considerations provide a framework for conceptualising three broad categories/subtypes of reading difficulties, each of which requires a different intervention strategy. Reading comprehension problems can result from weaknesses in recognising printed words, weaknesses in comprehending spoken language, or both.
- 7) After listing 15 characteristics that may be an indication of dyslexia, the author asserts that there are “three main deficit theories” of what causes these characteristics of dyslexia: the phonological theory, the cerebellar theory, and the magnocellular theory. However, it is misleading to suggest that these theories are equal in status. A more accurate statement would be to say that there is one main theory of the underlying cause of dyslexia (the phonological theory) and two minor ones (the cerebellar and the magnocellular theory), neither of which has gained widespread acceptance among dyslexia researchers.
- 8) The author briefly mentions another “theory” of dyslexia called the transactional theory, which is based largely on socio-constructivist theories of learning and the work of Marie Clay. However, the uncritical discussion of the transactional view results in a potentially misleading conclusion, as this “theory” has no solid research base and is not accepted by mainstream researchers. It therefore does not merit serious consideration.
- 9) Regarding neurobiological studies of dyslexia, there is no convincing evidence of anatomically-based, central nervous system dysfunction in the brains of dyslexics; that is, the persistent literacy difficulties of dyslexics do

not appear to be due to “hardware” problems in the brain. However, recent brain imagery studies of the neurobiological effects of successful reading interventions strongly indicate plasticity in the neurophysiological processes involved in reading and that persistent reading difficulties of dyslexics are largely due to “software” problems.

- 10) The most important finding emerging from brain imagery studies of the effects of intense, evidence-based interventions is that the activation profile of the successfully remediated poor readers becomes much more like the activation profile of normally developed readers and, with the passage of time, increasingly like that of skilled readers. In short, with the use of appropriate intervention strategies, students with persistent reading difficulties can be taught to use their brains in a more effective manner.
- 11) It is now widely accepted that assessing children’s strengths and weaknesses in reading should focus squarely on those reading and reading related skills that children must acquire as they learn to read. On the basis of a considerable amount of research on the development of reading ability, five broad areas of skills and knowledge have been identified: phonemic awareness, alphabetic decoding skills, fluency, vocabulary, and reading comprehension. Comprehensive reading assessment systems that have been developed in recent years have included developmentally appropriate measures of most or all of these skills.
- 12) The claim “a formal psychological evaluation is the only method, across English-speaking countries, that is recommended for diagnosis of dyslexia”, and when time and money constraints do not allow such comprehensive testing, “quicker, simpler screening tests are usually administered to detect signs or indicators of dyslexia” is largely inaccurate. This claim fails to acknowledge the strong movement toward the response-to intervention (RTI) approach to identifying students with dyslexia.
- 13) The author correctly notes that a major aim of any screening procedure is to select children who are truly in need of intervention (i.e. “true positives) to ensure that the most vulnerable children receive supplemental instruction, thus preventing the development of more significant reading problems. Recent research addressing these issues has demonstrated that RTI-based procedures are more effective in identifying at-risk students (true positives)

and not selecting those not in need (false positives) than standard psychometric procedures.

- 14) The remaining material in this section of the review focuses on descriptions of several assessment systems, most of which do not adequately assess manifest causes of reading disability (i.e. phonemic awareness, phonological decoding, fluency, vocabulary, reading comprehension). Four assessment systems are selected for detailed discussion, one of which is the Wechsler Intelligence Test for Children (WISC). This is rather surprising given the large amount of research indicating that IQ is largely irrelevant to the identification and treatment of dyslexia, and the fact that many, if not most school psychologists in New Zealand have appropriately discarded the use of such assessments as part of procedures for identifying reading/learning problems.
- 15) The final paragraph of the section seems to be tagged on at the end and includes several unsubstantiated and/or misleading claims. For example, the author states that “screening tests do not measure a child’s overall performance in reading’ and cannot be taken “as an authentic guide to reading success” because they all take the words out of context. But as noted earlier, most widely used reading assessment systems focus on essential component skills required to learn to read, including the ability to think actively while reading in order to construct meaning (i.e. comprehension strategies). The latter is typically measured by reading comprehension tests that require reading connected text, which would surely be regarded as an “authentic” reading activity. Most of the unsubstantiated claims made in the paragraph appear to be aimed at providing support for the final sentence of the paragraph.
- 16) A major shortcoming of this section of the background paper is the failure to describe a conceptual framework for implementing intervention programs in which a developmental model or reading acquisition provides the basis for systematic assessment, the results of which point to appropriate instructional strategies for struggling readers with particular learning needs.
- 17) In the discussion of prevention programs for children at risk of developing reading problems and remedial programs for students failing to make adequate progress in learning to read, the author states that developing

effective intervention methods for dyslexic children is “a challenging process because every person with dyslexia is different” but fails to mention how they are different.

- 18) The author notes that “even among the effective treatments, a particular treatment may work on one person but not another” but fails to offer an explanation for such differential effectiveness.
- 19) An area not covered that is relevant insofar as strategy instruction is concerned, relates to important cognitive-motivational factors associated with success or failure in reading (and other areas). There is now a considerable body of research evidence, conducted with struggling readers and children with learning disabilities, indicating that remedial interventions will be limited in their success if negative achievement-related self-perceptions and beliefs are not addressed in conjunction with strategy and skills instruction.
- 20) In this section the author provides an excellent discussion of the long-term consequences of persistent reading difficulties, all of which underscores the importance of early and effective intervention programs for dyslexic children.
- 21) Although the research discussed in this section of the review is interesting, the findings are of limited relevance as the general conclusion derived from cross-language comparison studies is that the underlying causes of dyslexia are most likely universal but the core deficit may differ with orthographic consistency.
- 22) Among other things, the author concludes that to determine the impact of international research on improving literacy levels of New Zealand dyslexic students will involve “designing and undertaking rigorous research that assess the effectiveness of those international findings in a New Zealand setting”. There can be no disagreement on this point, especially since the research carried out on dyslexic children in New Zealand is virtually non-existent.