Children’s reading impairments: From theory to practice

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Abstract: This paper outlines the nature and characteristics of children’s reading disorders and considers current ideas about the definitions of dyslexia and reading comprehension impairment. We argue that reading skills show continuous variations within the population, making the diagnostic “cut-offs” used in the identification of reading disorders essentially arbitrary. We argue that there is a considerable overlap between children’s reading and language disorders and discuss methods for the early identification of children’s reading disorders. We argue that interventions for reading disorders need to be evidence based, and review the evidence for the effectiveness of current approaches to intervention. We conclude by considering the extent to which learning to read in different languages may depend on some universal cognitive principles, as well as processes that may differ between alphabetic and nonalphabetic writing systems.

Key words: reading, learning to read, dyslexia, reading comprehension impairment, language impairment.

Scientific research on dyslexia has burgeoned during the past 50 years and a great deal is now known about its nature, etiology, and assessment. Against this backdrop, it should be possible for children who are at risk of reading failure to be identified early so that they can receive intervention before a downward spiral of underachievement, lowered self-esteem, and poor motivation sets in. This paper begins by reviewing the proposals for the new Diagnostic and Statistical Manual’s (DSM-V) definition of dyslexia, and proceeds to examine whether children with dyslexia and related literacy difficulties can be identified based on their response to good quality reading instruction. This aspiration was at the core of the recent independent review on dyslexia for the UK government, conducted by Sir Jim Rose (2009). The review advocated a three-tier system, beginning with high-quality mainstream teaching delivered to all, proceeding with adaptations and catch-up programs for those “at risk,” and finally individualized teaching for those in greatest need. A growing evidence base of effective interventions suggests that this aim could become a reality.

Reading difficulties

According to the Simple View (Gough & Tunmer, 1986), reading comprehension is the product of decoding and linguistic comprehension. If decoding skills are limited, text comprehension will suffer, and if language skills are weak, a child will read without understanding. Within this view, there are three sorts of poor
reader: those with poor decoding (dyslexia), those with poor language comprehension (poor comprehenders), and those with impairments in both decoding and language (listening) comprehension.

Dyslexia
Dyslexia is a neurodevelopmental disorder that primarily affects the development of reading accuracy, fluency and spelling skills (International Dyslexia Association, 2002). For some individuals, dyslexia persists well beyond the school years and may affect adult employment prospects (Maughan, Messer, Collishaw, Snowling, Yule, & Rutter, 2009), for others reading difficulties are compensated, although persistent deficits may be apparent in spelling and aspects of phonological processing (Bruck, 1992; Ramus, 2003). It is generally agreed that genetic risk factors are important in the etiology of dyslexia, and that more boys than girls are affected (though the sex ratio is higher in referred samples).

For many years, dyslexia was conceptualized as a specific reading difficulty affecting children for whom reading achievement was below that to be expected on the basis of a child’s age and IQ. Indeed, the two main classification manuals used in clinical practice at the time of writing follow the discrepancy formula for classifying children with learning difficulties (see Table 1 for the definitions included in the Diagnostic and Statistical Manual (4th ed.) American Psychiatric Association, 1994). However, the use of the discrepancy approach in educational settings has gradually declined because there is little evidence of differences in etiology and/or prognosis for children with learning difficulties who have a higher or lower IQ (Stanovich & Siegel, 1994), although it needs to be borne in mind that, in terms of reading comprehension, those with a higher IQ are likely to do better.

The predominant cognitive explanation of dyslexia is that it arises from a phonological deficit affecting the processing of speech sounds in words (Vellutino, Fletcher, Snowling, & Scanlon, 2004 for a review). Early manifestations are difficulties with the development of phonological awareness and, perhaps more so, problems with word recognition such as nystagmus or low vision accompanies the underachievement, the extent of learning delays should be far in excess of the known contribution of the sensory deficit. The co-occurring difficulty must also be coded.

All comorbidities should be recorded, such as attention deficits, emotional difficulties, and conduct disorders.

Other associated social-emotional difficulties are known to occur, including reduced self-esteem and self-efficacy for academic performance, and increased barriers for entry into school and post-school, training as well as in the world of work. The DSM-IV encourages that this and similar other associated difficulties are recorded.

Table 1 Criteria for diagnosis of a learning disorder according to the DSM-IV

<table>
<thead>
<tr>
<th>Disorder categories include Developmental Reading Disorder (315.00), Mathematics Disorder (315.1) and Disorder of Written Expression (315.2)</th>
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<tr>
<td>Child’s extent of learning must be substantially below that of peers who have received equivalent opportunity</td>
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<td>The lower levels of achievement must be seen to be interfering with academic achievement and daily living</td>
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<tr>
<td>When a known sensory deficit such as nystagmus or low vision accompanies the underachievement, the extent of learning delays should be far in excess of the known contribution of the sensory deficit. The co-occurring difficulty must also be coded.</td>
</tr>
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Note. DSM-IV = Diagnostic and Statistical Manual (4th ed.)

As we shall see, some children with dyslexia find ways of comprehending what they read reasonably well despite errors in reading individual words, and on the other side of the coin, poor reading comprehension can occur in children who are not dyslexic and have well-developed decoding abilities.

Given that reading skills have a continuous distribution in the population, the cut-off criterion used for the “diagnosis” of dyslexia is to some extent arbitrary, and estimates of its prevalence range from 3–10% of the population. In a recent test standardization, we collected data on the York Assessment of Reading and Comprehension (YARC; Snowling, Stothard, Clarke, Bowyer-Crane, Harrington, Truelove, & Hulme, 2009; Stothard, Snowling, Clarke, Barmby, Hulme, 2010) which comprises tests of single word reading, prose reading accuracy, reading rate, and comprehension, and is therefore a useful tool for indentifying children who are poor at decoding, poor at reading comprehension, or both. Pupils were randomly selected to participate in the standardization according to their date of birth, in order to ensure the sample was representative of the schools concerned, and schools were selected from different areas in an attempt to make the sample broadly representative of children in the UK.

As it is recognized that reading skills fall on a continuous dimension with no clear cut off between “normal” and “impaired” (dyslexia) reading, we considered a number of different criteria for the classification of decoding difficulties/dyslexia. Taking account of the prevalence estimates from previous epidemiological surveys, we used a standard score cut-off of 77.5 (1.5 SDs below the mean, approximately 7% of the population) to be indicative of dyslexia and a standard score cut-off of 70.0 (2 SDs below the mean, approximately 2% of the population) to indicate a severe impairment. Here we focus on the scores from a large sub-sample (1553) of children aged 6–16 years, being those who were attending 50 state-funded primary and secondary schools in England.

Broadly in line with expectation, 10.5% of pupils in the primary school sample obtained a standard score below 77.5, and 3.9% a score below 70.0 in single word reading. Similarly, within the secondary school sample, 8.1% had moderate decoding difficulties and 3.9% severe. More boys than girls were affected at primary school and the proportion of pupils with English as an additional language was significantly higher among poor decoders than in the remainder of the sample. Decoding difficulties were also more common among children from socially deprived areas. Together, these data remind us that social and cultural factors influence the prevalence of reading difficulties.

Importantly, the survey also underlined the fact that even when word-level decoding skills are poor, reading comprehension can be intact. Thus, 3.3% of the poor decoders in primary and 4.9% in secondary school showed a significant discrepancy between good reading comprehension (from the prose reading task) and poor reading accuracy (16–41 standard score points), a profile sometimes associated with discrepancy-defined dyslexia.

Problems of reading comprehension

As noted above, reading comprehension impairment is a distinct disorder from dyslexia. The cognitive profile of reading comprehension impairment contrasts markedly with that seen in dyslexia. Children with specific reading comprehension impairment (sometimes referred to as “poor comprehenders”) can decode and spell words accurately, but have problems understanding the meaning of what they read. Poor comprehenders have been much less studied than children with dyslexia and the condition is not well recognized by teachers (Hulme & Snowling, 2011 for a review). However, data from the YARC standardization (Snowling et al., 2009; Stothard et al., 2010) revealed that 5.3% of the primary sample and 5% of the secondary school sample could be defined as poor comprehenders in that single word reading was at the age-expected level with reading comprehension below a standard score of 77.5. Reading comprehension impairment is therefore quite a common disorder which at present often goes undetected.
Many children with reading comprehension impairment have wide-ranging oral language impairments coupled with good phonological skills (it is these that account for their ability to decode normally). Prospective studies starting in the very early stages of learning to read suggest that children who go on to be poor comprehenders show weaknesses in basic language skills, including weaknesses in vocabulary knowledge, grammar, and syntax from an early age (Catts, Adlof, & Ellis Weismer, 2006; Nation, Cocksey, Taylor, & Bishop, 2010). Poor comprehenders also experience higher-order language difficulties, including problems with inferencing and with figurative language use, and in text-related processes such as comprehension monitoring and knowledge of story structure (Cain, 2010). Whether these are a cause or a consequence of their reading comprehension impairments remains debated, and there is considerable heterogeneity within this group.

The relation between reading and language impairments

Although it is possible to identify children with pure reading disorders, such as dyslexia or reading comprehension impairment, most poor readers have difficulties in both areas to varying extents. What is clear is that, given reading is a written language process that builds on a foundation in oral language skills, children who come to school with poorly developed language skills are at high risk of reading disorders. Bishop and Snowling (2004) reviewed studies of the relation between reading and language impairments and proposed that in order to understand these inter-relations it is important to take a two-dimensional view which regards reading as building on both phonological and broader oral language skills (see Figure 1). Thus, children who enter school with poorly developed phonological skills (poor phonological awareness, phonological memory, or naming skills) are at risk of decoding difficulties, while children with broader language impairments are at risk of reading comprehension problems. The “type” of reading impairment they display will depend on a complex mix of their cognitive skills and language weaknesses, as well as the interventions they receive both formally in school and informally in the home environment. Children with clinically diagnosed specific language impairment generally have pervasive reading disorders with both processes affected.

In short, neither dyslexia nor reading comprehension impairment is a clear-cut diagnostic category and the overlap is considerable. In turn, in keeping with other neurodevelopmental disorders that affect learning, they should be thought of as the behavioral outcome of multiple risk factors, both genetic and environmental (Hulme & Snowling, 2009). Moreover, it is increasingly clear that both will co-occur with other disorders, although to date the evidence is strongest in relation to dyslexia. Thus, many children with dyslexia have language impairments (McArthur, Hogben, Edwards, Heath, & Mengler, 2000), symptoms of inattention or ADHD (Carroll, Maughan, Goodman, & Meltzer, 2005), and problems of motor coordination (Rochelle & Talcott, 2006). This nuanced view of dyslexia as a dimension which has continuities and comorbidities with other disorders has significant implications for contemporary theory and practice (see Snowling, 2012 for a review and access to related papers on changing concepts of dyslexia).

Spectrum of Reading Disorders

(after Bishop & Snowling, 2004)

Figure 1 Two-dimensional model of the relation between language and reading impairments (after Bishop & Snowling, 2004). L- = language; P- = phonology.


**Children at family risk of dyslexia**

In recent years there has been an increasing number of studies which follow children at high risk of dyslexia because they have a first-degree affected relative. The starting point for a family risk study is that reading skills are highly heritable, meaning that similarities between family members in reading are largely accounted for by genetic factors. If a child is said to be at “family risk” of dyslexia, this means that he or she has inherited an elevated risk of poor reading. Furthermore, as we have seen, reading skills are dimensional and there is no clear cut-off between dyslexia and “normal” reading. Thus, a child who is “at risk” can be considered to have inherited a tendency for reading skills to be within the lower band of a continuous distribution of reading skills. However, it is important to bear in mind that this risk is probabilistic and only partly determines outcome. What family risk studies have shown is that affected and unaffected family members share continuous risk factors for dyslexia, namely poor phoneme awareness and poorly developed letter knowledge. However, only some of the children in “high-risk” families reach a diagnostic threshold for dyslexia; the remainder might be said to have mild symptoms or conform to a “broader phenotype” of dyslexia, and of course some will be perfectly normal reader-spellers (Snowling, Muter, & Carroll, 2007).

One hypothesis regarding the differential outcomes of children at family risk of dyslexia is that they depend on the balance of cognitive skills the child brings to the task of reading (Bishop & Snowling, 2004; Snowling, 2011). Thus, it has been argued that children with good oral language may be able to use such skills to compensate early for a susceptibility to dyslexia associated with phonological difficulties (Snowling, Gallagher, & Frith, 2003). Other “protective” factors may include normal speed of processing as measured by rapid automatized naming (RAN) tasks (Bishop, McDonald, Bird, & Hayiou-Thomas, 2009; Pennington, 2006), perhaps motivation or reading intervention (Hindson, Byrne, Fielding-Barnsley, Newman, Hine, & Shankweiler, 2005).

In this light it is interesting that a number of family risk studies now show that so-called “unaffected” children are less good at reading and reading-related tasks, such as phonological awareness, than control children from families with no history of reading difficulty (low-risk groups). The continuity of risk for dyslexia is highlighted by a study from our group. In this study, we recruited a sample of children with a parent with dyslexia just before their fourth birthday (Gallagher, Frith, & Snowling, 2000). At the first assessment at 45 months, at-risk children were worse at repeating novel words, particularly those with phonological structures comprising late-acquired forms. In addition, their knowledge of nursery rhymes was poorer and they already knew fewer letters than children from control families in similar socio-economic circumstances.

When followed through to 8 years, the at-risk children as a group showed an elevated rate of literacy impairments (Snowling et al., 2003). Comparing at-risk “dyslexic” children with at-risk “typical” readers revealed that those children who had experienced delayed language development at 3 years and 9 months went on at 6 years to show difficulties in phonological awareness. In contrast, the high-risk but normally reading group were indistinguishable from controls on oral language tests (e.g., vocabulary and narrative) at all assessment points and were only mildly impaired in phonological awareness. However, there were also interesting similarities between the dyslexic and the unimpaired high-risk children: both groups showed poorer letter knowledge and spelling skills at 6 years than controls, highlighting the genetic liability. An intriguing possibility is that these symptoms are indicative of a specific difficulty in creating mappings between visual (letter) and verbal (sound) modalities, a hypothesis that can be traced back to the writings of Geschwind, who considered dyslexia to be a “disconnection” syndrome which has resurfaced in contemporary brain imaging studies (Blau, van Atteveldt, Ekkebus, Goebel, & Blomert, 2009; Price & McCrory, 2005).

Arguably, the outcomes of children at family risk of dyslexia may also depend on the language
of learning. Among alphabetic languages, family risk studies have now been completed in children learning to read in opaque orthographies, such as English (Pennington & Lefly, 2001; Scarborough, 1990) and Danish (Elbro, Borstrom, & Petersen, 1998) and in transparent orthographies, such as Dutch (van Alphen, de Bree, Gerrits, de Jong, Wilsenach, & Wijnen, 2004; Boets, De Smedt, Cleuren, Vandewalle, Wouters, & Ghesquière, 2010) and Finnish (Lyytinen, Erskine, Tolvanen, Torppa, Poikkeus, & Lyytinen, 2006, for an overview). A fairly consistent picture has emerged from these studies, revealing that delays in speech and language development are the earliest precursors of dyslexia and that prognosis is particularly poor if receptive language is affected (Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010). Later, at school age, children at family risk who develop dyslexia differ from controls in phonological awareness and phonological memory, as well as on RAN tasks. However, what is more surprising and of theoretical importance is that a “step pattern” is common in the data. Thus, children at family risk who develop dyslexia perform less well than the family-risk-normal readers, who in turn perform less well than controls from low-risk groups on phonological tasks, while alphanumeric RAN tends to emerge as a deficit specific to dyslexia (and not associated with the broader phenotype; Boets et al., 2010).

Within family risk studies in alphabetic languages, the best predictors of literacy outcome are age-related and, in line with Walley’s (1993) hypothesis, vocabulary appears to mediate the impact of oral language development on the development of phoneme awareness. There is also some evidence of a role of home literacy environment on literacy outcome; again, it appears to have an indirect influence on phoneme awareness mediated by vocabulary. More directly, three studies in transparent orthographies have suggested that parental reading skills account for significant variance in children’s reading outcomes (approximately 25%) after children’s own performance on tests of reading precursor skills are controlled for (van Bergen, de Jong, Plakas, Maasen, & van der Leij, 2012; Torppa, Eklund, van Bergen, Lyytinen, 2011). In contrast, Snowling et al. (2003) reported no significant relation between parental and child literacy skills in children learning to read in English. This finding is in need of replication, but it suggests that genetic risk factors play a smaller role in causing reading difficulties among children learning to read in English than in more regular orthographies. If this is true, it would lead us to speculate that learning to read in English may be more dependent on environmental factors (reducing the genetic variance) than in Dutch or Finnish; but this is a conjecture that needs much more evidence to substantiate it.

Finally, there is also some evidence concerning the precursors of dyslexia in children learning the logographic Chinese writing system. McBride-Chang, Lam, Lam, Doo, Wong, and Chow (2008) reported data from the first phase of a family-risk study when children were 5 years of age. Individual differences between children in word recognition were best explained at this time point by variations in morphological awareness, tone detection, and visual skill, which is a rather different list of predictors to those reported for alphabetic languages. Moreover, children at family risk performed more poorly in morphological awareness, tone detection, and Chinese word recognition than controls. In a later follow-up study when the children were 7 years of age (McBride-Chang, Lin, Liu, Aram, Levin, Cho, Shu, & Zhong, 2012), 50% of the family-risk group had developed dyslexia. At this time point, children with dyslexia (which included not only children from the family-risk group, but also from a group of children with specific language impairment) performed less well than controls in morphological awareness and RAN. Overall, morphological awareness was the best predictor of reading accuracy, and RAN of reading speed. Furthermore, within the group with dyslexia, visual skills predicted variations in outcome (Wang, Bi, Gao, & Wydell, 2010).

Together, these findings indicate that there is no single or universal cause of dyslexia, but knowledge of how reading typically develops can help guide understanding of the risk factors that operate to cause dyslexia (Caravolas, © Japanese Psychological Association 2012.
2005). In alphabetic languages, learning to read is heavily dependent on phoneme awareness and letter knowledge, at least in the early stages, and RAN contributes additional variance to the development of reading fluency (Caravolas, Lervåg, Mousikou, Efrim, Litavsky, Onochie-Quintanilla, Salas, Schöffelová, Defior, Mikulajova, Seidlová-Málková, & Hulme, 2012; Lervåg, Bråten, & Hulme, 2009). In Chinese, awareness of the tone of syllables and the morphological constituents of words are important predictors of reading accuracy. Arguably, this pattern of prediction reflects the nature of the mappings between print (Chinese character) and sound (syllable and tone) and print and meaning (morpheme), represented in the orthography as semantic and phonetic radicals that comprise the characters; RAN is also an important predictor of reading speed.

In summary, it is clear that dyslexia is likely to be the outcome of multiple risk factors which accumulate toward a threshold for identification. In line with this, Snowling (2008) reported that children who had multiple deficits in phonological awareness, language, attention, and visual skills were more likely to be classified as dyslexic than children with similarly poor levels of phonological awareness whose impairments were selective. Similar findings emerged from a case series of children with dyslexia learning to read in Kannada, an alphasyllabic language of southern India (Nag & Snowling, 2011), suggesting this is likely to be true universally. More generally, Aro, Pioikkeus, Eklund, Tolvanen, Laakso, Viholainen, Lyttinen, Nurmi, and Ahonen (2009) investigated the multiple risks associated with dyslexia beyond cognition, including family adversity. From all this evidence, we can conclude that the greater the accumulation of risk factors the greater the likelihood of a child developing dyslexia.

**Early identification of children at risk of literacy problems**

For many years, the importance of early identification and intervention for children at risk of educational achievement has been stressed. Arguably, the field is now in a good position to develop screening instruments that will assist in the early identification of dyslexia. However, although significant progress has been made in identifying cognitive skills which predict literacy outcomes on a group basis (e.g., in English letter-sound knowledge, phoneme awareness; Muter, Hulme, Snowling, & Stevenson, 2004), at the individual level it is much harder to make accurate predictions (Puolakanaho, Ahonen, Aro, Eklund, Leppanen, Poikeus, Tolvanen, Torppa, & Lyttinen, 2007). In this light, the merits of costly screening and assessment procedures must be questioned.

**Using teacher assessments in the identification of children at risk of literacy difficulties**

Assessing children on formal tests takes time and the data can be misleading when children are not used to such testing procedures. Moreover, there is quite a high degree of imprecision in the early screening of language skills because many children resolve their difficulties without intervention (Bishop & Edmundson, 1987). A reasonable question, therefore, is whether teachers can make valid judgments about children’s development in order to screen for potential problems; teachers see children on a daily basis and can sample their behavior in a variety of settings.

In English schools since 2003, the assessment of children’s progress at the end of the Foundation Stage (from 3 to 5 years) has been formalized. To investigate whether a teacher-assessment undertaken after children have been in school for 1 year could provide a screening tool for the identification of children at risk of dyslexia, we investigated pupil data from this assessment, the Early Years Foundation Stage Profile (EYFSP) in one local education authority. Data were available from two whole cohorts of children entering all 50 maintained primary schools within this authority (Snowling, Hulme, Bailey, Stothard, & Lindsay, 2011).

The EYFSP (see https://www.education.gov.uk/publications/eOrderingDownload/DFE-RR172a.pdf) comprised 13 scales within six areas of learning, each containing nine scale points. The areas of learning were: Personal,
Social, and Emotional; Communication, Language, and Literacy; Problem Solving, Reasoning, and Numeracy; Knowledge and Understanding of the World; Physical Development; and Creative Development (including art and craft work). On each scale, points four to eight are the early learning goals, points one to three describe attainment below the early learning goals, and point nine describes the attainment of a child who is working consistently beyond these. To validate the EYFSP, longitudinal data were collected 2 and 3 years later. These included attainment levels at the end of Year 2, when there is a statutory obligation on schools to assess reading, writing, and mathematics, and literacy data on objective tests from a representative sample of children followed up in Year 3.

We first examined correlations between teachers’ ratings of Children’s Communication, Language, and Literacy (CLL) and their more formal assessments 2 years later informed by observations, statutory tasks, and tests. In support of the predictive validity of the teacher ratings, the score for CLL at the end of the first school year (Reception class) correlated strongly with performance 2 years later at the end of Year 2 in Reading (.71) and Writing (.69) attainments. In fact, 50% of the differences between children in these assessments (at approximately age 7 years) could be accounted for by teachers’ ratings of their CLL at the end of Early Years (at approximately age 5 years) on the EYFSP.

Researcher-administered literacy tests were given at the end of Year 3. These included tests of word reading and spelling, prose reading, and comprehension; we also formed a Literacy factor score from scores on all of the reading and spelling measures, which provided a very reliable estimate of literacy skills. There were moderate correlations between the EYFSP score for CLL and measures of reading, spelling, and reading comprehension 4 years later in Year 3, and the correlation between children’s CLL and the Literacy factor was .59. Together, these findings show that teacher assessment at 5 years, based on ongoing observation, provides a valid measure of children’s current development. The findings underline the importance of language and communication as a critical foundation for learning, and show that teachers can do a reasonably good job of identifying children who are at high risk of reading difficulties. If teachers also had knowledge of a child’s family history of literacy, then it should be the case that they could make very precise judgments about who in their class has additional educational needs. Arguably, they should be empowered to do so, rather than be required to await psychological assessment.

**Screening for dyslexia using a Response to Intervention framework**

The findings from the EYFSP suggest that the risk of reading and writing difficulties is apparent early in development and that a screening tool targeting early language, literacy, and communication skills has the potential to identify children who will go on to be dyslexic. However, no screening tool is perfect and hence it is important to include additional checks on children’s development to reduce the probability of over- and under-identification of learning difficulties. In this regard, the Response to Intervention (RTI) framework offers a useful adjunct to a screening tool, because it involves monitoring the progress of children in receipt of a given curriculum.

The RTI (Fletcher, Reid Lyon, Fuchs, & Barnes, 2007), as its name suggests, involves monitoring the progress of a group of children through a program of intervention rather than undertaking a static assessment of their current skills. Children with the most need are those who fail to respond to effective teaching and they are readily identified using this approach. In the UK at present, three waves of intervention are defined for children who experience difficulties in learning to read (Rose, 2009). Wave 1 is the least intensive, and in this wave each child should receive high-quality phonically based teaching in mainstream classes, perhaps adapted for the slower learners in the class. Following this, at Wave 2, a small group or catch-up program is offered, and at Wave 3 an individualized intervention occurs. Within this approach, a child need not wait to fulfill
diagnostic criteria but will be offered support as soon as they are dropping behind (Rose, 2009).

In the UK at the time of writing, most children are taught according to the National Curriculum, with reading being taught using systematic phonics instruction. A large body of evidence suggests that such an approach is very effective for teaching children to read (National Reading Panel, 2000; Torgerson, Brooks, & Hall, 2006). It follows that children who are finding reading difficult despite this well-founded approach, are likely to be at risk of dyslexia.

The local authority with which we had worked for the EYFSP research had implemented a systematic phonics curriculum beginning in 2006. Moreover, in line with policy recommendations, teachers were trained to track pupils’ progress through a series of developmental phonetic phases, with each phase being quantified by a number of phonics-related skills (Department of Children, Schools & Families, 2008a,b). The phases move from sensitivity to rhyme and alliteration at Phase 1, to confident and fluent use of letter-sound knowledge (grapheme-phoneme correspondences; GPCs) for reading and spelling unfamiliar words at Phase 6. As we had collected data from whole cohorts of children on a term-by-term basis, we were able to use this to identify children who were “failing to thrive” in terms of their progress in phonics. We decided to carry this out when the children were approximately 6 years of age and had been in receipt of reading instruction for just over 1 year (Snowling, Duff, Petrou, Schiffeldrin, & Bailey, 2011).

Using school records, our criterion for “dyslexia risk status” was taken to be “not secure in Phonic Phase 2 at the end of the fourth term in school.” Phonic Phase 2 requires the child to be able to provide the sound when shown any grapheme that has been taught, particularly being secure with the sounds of s, a, t, p, i, n; to select the correct grapheme to represent any of the 19 phonemes taught in this phase; and to blend and to segment consonant-vowel-consonant and vowel-consonant words. Based on these criteria, 16.4% of the school population was assessed as “behind expectation” in phonetic skills. Because this is well above the reported prevalence rates for dyslexia (typically 7–10%), it is clear that these judgments alone would over-identify children who subsequently go on to be “free” of difficulty. However, to assess the validity of the teacher judgments, we proceeded to assess the same children at the end of Year 1, some 6 months later, on objective tests of reading and related skills, comparing them with a representative sample of children from the same classrooms, matched on age and sex.

The findings of our study were clear: teachers’ judgments predicted 50% of the variability in children’s reading skills at the end of the school year and, bear in mind that objective test scores rarely produce better agreement over two points in time. However a more specific question was did these children conform to a definition of dyslexia by showing key phonological deficits? Accordingly, the group of children identified as at-risk were assessed on tests of letter-sound knowledge, phoneme awareness, verbal working memory, and RAN, as well as on objective reading measures, and compared with a randomly selected control group of peers from the same classrooms. On all of these tests, the at-risk group was impaired. We therefore proceeded to consider which combination of tests best classified children with reading difficulties (1 SD below average, a standard score of 85). Just two tests (sound isolation (a measure of phoneme awareness) and RAN colors; Lervåg & Hulme, 2009) classified 92.1% of cases correctly (92% of children with significant reading difficulties could be identified, and 90% of those with adequate reading were not identified). On the basis of these findings, a recommended procedure for early identification of dyslexia might involve a two-step process. First, teacher observations can be used to identify children who are at-risk (ideally supplemented by family-risk data), and these observations can be “firmed up” by the administration of two further tests: sound isolation and RAN colors.

In summary, although there are many commercially available screening tests designed to identify children at risk of dyslexia, there is really no need to implement such costly...
procedures. In many schools there are data which could be used to identify children who are failing to respond to mainstream teaching. A distinct advantage of teacher assessments is that these occur on a regular basis, and can avoid delays in the implementation of good quality evidence-based intervention. Ideally, school systems should embed such procedures in their policies and empower teachers to identify children with additional learning needs at an early stage. Where procedures are not yet in place, checklists and protocols can be developed that draw on the best evidence.

Interventions to ameliorate dyslexia

A theoretical understanding of the causes of learning disorders should provide the rationale for the development of intervention programs, and assessment protocols should be designed to lead into the delivery of effective interventions. Unfortunately, the field of dyslexia is plagued with advertised “cures” which have no evidence base (Bishop, 2007). Too many practitioners are failing to properly understand the core features of reading disorders, which are basically the skills that require remediation, versus the comorbidities that themselves may be the legitimate targets of different forms of intervention. For example, in a well-controlled study, McArthur, Ellis, Atkinson, & Coltheart, (2008), showed that training in auditory discrimination improved auditory processing, but there was no transfer of training to reading skills. However, auditory interventions such as Fast ForWord are still marketed for dyslexia even though a systematic meta-analytic review has shown that there is no evidence for the effectiveness of the program (Strong, Torgerson, Torgerson, & Hulme, 2011). It falls to researchers and practitioners alike to take a critical stance toward commercially available programs for the amelioration of dyslexia (Bishop, 2008). Indeed, a general principle that we would advocate is that of a “virtuous circle;” theory should inform practice and, in turn, the findings of practice should inform theory. That said, there is a pressing need to develop effective interventions for dyslexia and reading comprehension impairment, as well as combined approaches that target both disorders for children with more pervasive impairments.

Early interventions at the foundations of literacy

Given what is now known about the early precursors of dyslexia, it should be possible to design effective interventions that will strengthen the foundations of literacy in children who show signs of being at risk.

Bowyer-Crane, Snowling, Duff, Carroll, Fieldsend, Miles, Goetz, & Hulme, (2008) designed a set of two interventions, one targeting Oral Language (OL) and the other targeting Phonology and Reading (P&R), for children who entered school with poorly developed language skills. The OL program had three main components: speaking and listening activities, vocabulary instruction, and training in spoken narrative. The P&R program comprised training in letter-sound knowledge, segmenting and blending, and reading from texts which were selected to be at the appropriate level following the administration of a “running record” (Hatcher, 2006). The programs were delivered each day for 20 weeks to children in Reception and Year 1 classes by trained teaching assistants, alternating between small group (30 min) and individual (20 min) teaching sessions (see Carroll, Bowyer-Crane, Duff, Hulme, & Snowling, 2011 for details).

At the end of the intervention and at follow up 5 months later, both programs were found to be effective in raising target skills. Thus, the children who received the P&R program did significantly better than those who received the OL program on tests of phoneme awareness, letter-sound knowledge, and reading and spelling skills, whereas the children who had received the OL intervention did better in expressive grammar, in a test requiring picture sequencing, and on tests of the vocabulary they had been taught. Importantly, it appeared that the P&R intervention program had lifted many of the children from being at risk to the typical range of reading skills for their age: while...
68.1% of the OL group remained at risk for literacy difficulties, this was only the case for 50% of the P&R group. In fact, 7.1% of children in the P&R group now had above average reading scores.

Of course, no intervention program benefits all children and inevitably there is variation in children's response. We found that one factor that predicted progress was nonverbal IQ, such that children with more specific language impairment tended to do better than children with a general language delay (Bowyer-Crane, Snowling, Duff, & Hulme, 2011). However, our sample size was small for exploring predictors of response and it is important at this stage to be cautious about such findings.

**Treating dyslexia**

Beyond the early years, there are now many evidence-based interventions for children with reading difficulties or dyslexia (Duff & Clarke, 2011; Fletcher et al., 2007; Snowling & Hulme, 2011). However, in order to choose an effective program or approach, professionals require a good understanding of the principles of interventions and their suitability for different children. Snowling and Hulme (2011) reviewed the ingredients of evidence-based interventions for language and literacy difficulties. They concluded it is good practice to ensure that interventions are systematic, well structured, and multi-sensory, and that they incorporate direct teaching, learning, and time for consolidation, with frequent revision to take account of the likely limited attention and learning difficulties of the child. For interventions to be effective for dyslexic readers (at least of alphabetic orthographies), they should include training in letter-sounds, phoneme awareness, and linking letters and phonemes through writing and reading from texts at the appropriate level to reinforce emergent skills. In contrast, poor comprehenders require a different “diet” attuned to their needs, and can benefit from training in oral language skills, in particular vocabulary training, as well as work on story structure and narrative (Clarke, Snowling, Truelove, & Hulme, 2010: http://readingformeaning.co.uk/). Of course, it is important to bear in mind that many children will have problems with decoding and comprehension, in which case a mixed approach is needed. It is also the case that many interventions are short in duration and there is an urgent need for the ongoing needs of many children with moderate to severe reading difficulties to be recognized.

**Implications for reading and reading disorders in Japanese**

It would be inappropriate to end this article without acknowledging that there are obvious differences between learning to read in an alphabetic language, such as English, in which most research has been done, and learning to read in Japanese. It would be inappropriate to make recommendations about dyslexia research and practice in Japan without acknowledging the major differences between the English and Japanese languages in their spoken and written forms. However, we do believe that many of the principles identified in our review of reading development and reading disorders in English will be relevant to research and practice in Japan. Here we will draw together the findings that we believe are universal for a science of reading and its interventions, and aim to specify some of the processes which we hypothesize are orthography-specific.

First, in all languages, written language is a cipher for spoken language and hence literacy builds on a foundation of oral language skills. It follows that children with delays and difficulties in speech and language development will be at high risk of reading problems, regardless of the language of learning. In particular, their weaknesses are likely to impact the development of reading comprehension, but decoding may also be affected.

Second, there are two predictors of reading that appear to be universal. These are knowledge of the symbols that make up the writing system and naming speed for familiar objects or alphanumeric stimuli (RAN). RAN is a complex task that taps a number of different perceptual (Powell, Stainthorp, Stuart, Garwood, & Quinlan, 2007) and executive (Clarke, Hulme, &
Snowling, 2005) processes, but critical components are the ability to rapidly map between visual and verbal domains and to retrieve the phonological name codes associated with symbols (McCrory, Mechelli, Frith, & Price, 2005). There is evidence that RAN predicts learning to read in alphabetic languages, for example, German (Moll, Fussenegger, Willburger, & Landerl, 2009), Norwegian (Lervåg & Hulme, 2009), and Finnish (Puolakanaho et al, 2007), alphasyllabaries, for example, Kannada (Nag & Snowling, 2012), and in the logographic Chinese (Georgiou, Parrilla, & Liao, 2008; McBride-Chang & Ho, 2000). It is possible that the ability to learn letter-sound correspondences in English, or character-sound correspondences in more complex orthographies like Kanji, is linked in some way to RAN proficiency. Many of the same processes are involved (visual-verbal mapping, phonological retrieval) and it has been suggested that similar brain regions subserve these processes (Froyen, Willems, & Blomert, 2010; Price & McCrory, 2005).

However, there are also many differences between orthographic systems, not least in the number of symbols they comprise: languages that use an alphabet have small symbol registers (typically fewer than 35 symbols), while nonalphabetic orthographies such as Chinese and Japanese Kanji contain many thousands of symbols. The pace of learning the symbol set varies as a consequence. In alphabetic systems, children usually quickly master the basic symbol set, typically within one school year. However, in nonalphabetic systems, new symbols continue to be learnt in middle and high school, and beyond (Wydell & Butterworth, 1999).

The differences between alphabetic and nonalphabetic orthographies have implications for understanding children who fall behind in literacy. In the alphabetic systems, knowledge about the small number of symbols is easily gained and individual variations in letter knowledge largely disappear after a short period of formal education (the first one or two years of literacy instruction), although nonetheless within this period, variations in letter knowledge are a powerful predictor of individual differences in reading achievement (Bowey, 2005 for a review). In nonalphabetic systems, because new symbol learning takes place over a protracted period of time, children show variations in their levels of symbol knowledge in middle and even high school. Symbol knowledge thus becomes a robust concurrent (as well as longitudinal) predictor of individual differences in literacy development (for Indian akshara systems: Nag, 2007; Nag & Snowling, 2011; for Chinese: Tong, McBride-Chang, Wong, Shu, Reitsma, & Rispens, 2011) and we assume this will also be the case for children learning to read the Japanese Kanji.

Third, a range of family, school, socioemotional, and environmental factors undoubtedly influence learning to read, although these have not been our concern here. However, one aspect of learning to read in Japanese that makes it different from learning in European languages is that children learn to read in two orthographies, Kana and Kanji. This form of “bi-scriptality” has been the subject of some research (Uno, Wydell, Haruhara, Kaneko, & Shinya, 2009) and it is likely to pose considerable demands on children’s resources for learning and may therefore slow their reading acquisition. Moreover, it is possible that the learning of different scripts will draw on different cognitive abilities, for example, Kanji characters are much more complex visually than the symbols in alphabetic orthographies, and hence learning Kanji may place heavier demands on visual discrimination and visual memory skills (Uno et al., 2009).

A further issue that is script-specific is the grain size of the mappings between orthography and phonology, which, in turn, determine the size of the phonological unit children need to be aware of in learning about the way the orthography maps to phonology (Ziegler & Goswami, 2005). Whereas in English and other alphabetic systems the mappings are (largely) between letters and phonemes, in Kana they are at the level of the mora. In contrast, in logographic systems there is much less systematicity, and mappings are primarily to units of meaning (morphemes; Wydell & Butterworth,
1999). In an influential paper, Ziegler and Goswami (2005) proposed that reading development is shaped by three factors: the availability (or accessibility) of different phonological units prior to reading (i.e., the phonological structure of the ambient language, Caravolas & Bruck, 1993), the consistency of the orthography-phonology mappings in the language that the child is learning, and the granularity of the orthography, specifically whether mappings are at the level of smaller or larger units. Within this “psycholinguistic grain size” framework, the successful development of reading requires the child to use grain sizes in the symbol system of their language that allow an optimal mapping to the phonology of their language. It follows that languages in which there are mappings to orthographic units at more than one unit size (e.g., single letters and letter strings in English) present more of a challenge to the learner than orthographies that contain predominantly small or large units (e.g., German with grapheme level units or Korean with syllable level units).

Turning to Japanese, the mora is a more accessible unit than the phoneme, and the consistency of Kana is higher. Both of these characteristics predict that learning to read in Kana will be easier than in English (Uno et al., 2009; Wydell & Butterworth, 2009). However, given the need to learn to read both Kana and Kanji, the reading system must permit both finer (mora-symbol) and coarser (morpheme-character) grained mappings (Wydell & Butterworth, 2009); such “granularity,” together with the large symbols set to be learned, will challenge young readers and will be a particular difficulty for those at risk of dyslexia (Uno et al., 2009).

Conclusions

As knowledge of reading and reading difficulties has increased, not only in readers of English, but also other languages (Caravolas, 2005; Nag, Caravolas, & Snowling, 2011), there remains a pressing need for theory to influence practice. This paper has attempted to demonstrate how an understanding of dyslexia can be used to ensure that the children in our school systems who are at risk of dyslexia can be identified early, before a sense of failure sets in. The emphasis has been on dyslexia as a dimensional disorder rather than as a discrete diagnostic. Finally, the evidence shows that children with dyslexia and related literacy difficulties can be helped by specific interventions. This underlines the need for timely action based on school-based assessments of children’s progress in learning to read, rather than waiting for diagnosis.

References


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(Received January 29, 2012; accepted July 7, 2012)