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J Learn Disabil 2010 43: 229 originally published online 15 October 2009
DOI: 10.1177/0022219409345009

Hammill Institute on Disabilities

Journal of Learning Disabilities
43(3) 229–243

DOI: 10.1177/0022219409345009
http://journaloflearningdisabilities.sagepub.com
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Abstract

In 2007, the New Zealand Ministry of Education formally recognized the condition of dyslexia for the first time and has subsequently developed a working definition of the condition. The aim of this article is to draw on contemporary theory and research on reading development, reading difficulties, and reading intervention to describe what the authors believe are four key components of a definition of dyslexia/reading disability. They begin by discussing some preliminary factors that need to be considered in developing a definition of dyslexia. The authors then present the four components of their proposed definition, drawing on a framework for conceptualizing reading difficulties derived from the simple view of reading. They conclude by comparing their definition of dyslexia with the working definition put forward by the ministry.

Keywords

dyslexia, reading difficulties, reading intervention

In 2007, the New Zealand Ministry of Education formally recognized the condition of dyslexia for the first time. Prior to this point, the ministry had opposed the recognition of specific learning disabilities because adopting such a policy was thought to conflict with the country's noncategorical, needs-based system of special education (Tunmer & Chapman, 2007). The ministry instead opted for a more generic approach to meeting the needs of struggling readers, which included Reading Recovery (RR), a nationally implemented early intervention program developed by Clay (2005a, 2005b) to help children having trouble learning to read after a year of formal reading instruction.

Although the ministry has developed a working definition of dyslexia based on an extensive review of the international literature, it has not reached agreement on a final definition, stating that "defining dyslexia is a complex and contested process and there are no agreed definitions internationally" (New Zealand Ministry of Education, 2008, p. 1). While definitions of dyslexia do vary considerably, the ministry has probably overstated the problem somewhat. International organizations concerned with dyslexia, such as the International Dyslexia Association, have in fact been able to agree on a definition of dyslexia (Lyon, Shaywitz, & Shaywitz, 2003). The aim of this article is to draw on contemporary theory and research on reading development, reading difficulties, and reading intervention to describe what we believe are four key components of a definition of dyslexia/reading disability. We begin by discussing some preliminary factors that need to be considered in developing a definition of dyslexia. We then present the four components of our proposed definition, drawing on a framework for conceptualizing reading difficulties derived from the simple view of reading (Gough & Tunmer, 1986). We conclude by comparing our definition of dyslexia with the working definition put forward by the ministry.

Preliminary Considerations

Researchers concerned with dyslexia have concentrated their efforts on answering three key questions: What is it? What causes it? What can be done about it? Although the focus of recent research has been on the latter question, the answers to these questions are highly interrelated and cannot be pursued in isolation from one another (Tunmer, 2008; Tunmer & Greaney, 2008). Our conceptualization of what reading is and how it is acquired will greatly influence how we define dyslexia, what we think causes problems in learning to read, and what we believe are the most effective intervention strategies for helping students to overcome persistent literacy learning difficulties. Dyslexia should therefore be viewed as a hypothetical construct embedded within a broader theory of reading.

For example, underpinning the approach to literacy teaching and intervention recommended in RR (Clay, 2005a, 2005b) and ministry publications such as *Effective Literacy Practice* (New Zealand Ministry of Education, 2003) is the

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"multiple cues" theory of reading acquisition. Multiple cues theorists incorrectly assume that skilled reading is a process in which minimal word-level information is used to confirm predictions about the upcoming words of text based on multiple sources of information (Clay, 1991; Smith & Elley, 1994). Unlike fluent readers, according to this view, poor and beginning readers are less able to make use of contextual redundancy in ongoing sentence processing. Reading acquisition is therefore seen largely as a process in which children learn to use multiple cues in identifying words in text, with text-based cues (i.e., picture cues, semantic sources of information, syntactic sources of information, preceding passage context, and prior knowledge activated by the developing meaning of the text) being used mostly to generate hypotheses (i.e., predictions) about the text yet to be encountered and letter-sound information generally being used for confirmation and self-correction. As Clay (1998) put it, beginning readers

> need to use their knowledge of how the world works; the possible meanings of the text; the sentence structure; the importance of order of ideas, or words, or of letters; the size of words or letters; special features of sound, shape and layout; and special knowledge from past literary experiences *before* they resort to left to right sounding out of chunks or letter clusters or, in the last resort, single letters. (p. 9, italics added)

According to multiple cues theorists, focusing too much attention on the development of word-level skills and strategies may actually contribute to reading failure by diverting the child's attention away from what are considered to be more productive strategies (Smith & Elley, 1994). In her most recent work, Clay (2005a) warned that "undue attention to the detail of letters . . . can block the child's ability to use his language knowledge and the meaning of the text, as part of his information base for decision-making" (p. 25). Clay (2005b) explicitly stated that if the child has a bias toward using mainly letters to identify unknown words in text, "the teacher's prompts will be directed towards the message and the language structure" (p. 112). That is, when children show a preference for using word-level information to identify unknown words in text, Clay recommends that the teacher should divert their attention away from such information.

This approach to early intervention is reflected in the use of the running record, the primary assessment tool used by both RR teachers and most regular classroom teachers in New Zealand. A running record is a copy of a read passage on which the student's oral reading errors are recorded. The procedure for analyzing the errors was derived from miscue analysis, which was introduced in the 1960s by Ken Goodman (1967), a leading proponent of the multiple cues view of learning to read. In an example of the use of running records from Clay (2000), a child incorrectly read *lake* for *lady*, *box* for *boy*, *bil* for *bicycle*, and *square* for *squashed*. According to the analysis of these errors, because the child already appears to be using visual cues (i.e., initial letters) and structural cues (i.e., syntax), the teacher should encourage the child to make greater use of meaning cues when attempting to identify unfamiliar words (see also Blaiklock, 2004). We maintain that this is precisely the wrong thing to do. Chapman, Tunmer, and Prochnow (2001) found in a longitudinal study of RR that the students who failed to achieve significant progress or maintain the gains made in the program typically had limited or severely limited phonemic awareness and phonemically based decoding skills. For these children, more intensive and systematic training in phonological skills is likely to be required than what is normally provided in RR lessons (Iversen, Tunmer, & Chapman, 2005; Tunmer & Chapman, 2004; Tunmer & Greaney, 2008). In support of this claim, Reynolds and Wheldall (2007) found in a recent review of research on RR that the program "has not demonstrated that it works for students who are most at risk of failing to learn to read" (p. 213), leading them to conclude that "the success of the program appears to be inversely related to the severity of the reading problem" (p. 219).

The major shortcoming of the instructional philosophy espoused by Clay (1998, 2005a, 2005b) and adopted by the ministry is that it stresses the importance of using information from many sources in identifying unfamiliar words in text without recognizing that skills and strategies involving phonological information are of primary importance in beginning literacy development. As Pressley (2006) pointed out, "the scientific evidence is simply overwhelming that letter-sound cues are more important in recognizing words . . . than either semantic or syntactic cues" (p. 21) and that "teaching children to decode by giving primacy to semantic-contextual and syntactic-contextual cues over graphemic-phonemic cues is equivalent to teaching them to read the way weak readers read!" (p. 164). One of the major distinguishing characteristics of struggling readers is their tendency to rely heavily on sentence context cues to compensate for their deficient alphabetic coding skills (Stanovich, 1986).

Aside from scientific evidence, the validity of the claim concerning the critical role that letter-sound knowledge plays in early literacy development becomes almost self-evident when one considers learning to read in a nonalphabetic orthography like Japanese kanji, which is based on borrowed or modified Chinese logographs. It takes 10 to 12 years of devoted study to learn to recognize 1,000 to 2,000 logographs (Akamatsu, 2006), whereas the average high school student who has learned to read an alphabetic orthography can recognize quickly and accurately 25,000 words or more. This begs the question of what is the source of this enormous difference? The Japanese student presumably has access to all the same cues (picture cues, word shape cues, sentence context cues, preceding passage content, activated prior

knowledge, etc.) as the child learning to read an alphabetic orthography, save one: letter-sound cues. The latter cues clearly make a huge difference in learning to read, a fundamental point that proponents of instructional approaches based on multiple cuing systems do not take into account. Elsewhere, we have argued that the use of the multiple cues approach to literacy instruction and intervention has been a major contributing factor to the relatively large literacy achievement gap that New Zealand has consistently shown in international studies of reading achievement over the past 20 years (Tunmer, Chapman, & Prochnow, 2003, 2004, 2006; Tunmer et al., 2008; Tunmer & Prochnow, 2009).

Components of a Definition of Dyslexia

Persistent Literacy Learning Difficulties

The first component of our definition of dyslexia is that it refers to persistent literacy learning difficulties, especially difficulties in word recognition, spelling, and phonological recoding, where phonological recoding is the ability to translate letters and letter patterns into phonological forms. An immediate issue that arises in connection with this component of our proposed definition concerns the use of the word *persistent*. Traditionally, dyslexia has been defined as a discrepancy between reading achievement and intellectual potential as measured by standardized intelligence tests, that is, as a difference between reading age and mental age. An important consequence of this discrepancy-based assessment procedure is that children with dyslexia are not normally identified until after they have been exposed to reading instruction for 2 to 3 years, and often longer. This "wait-to-fail" approach to identification is antithetical to early intervention and the prevention of negative (poor-get-poorer) Matthew effects in reading (Fuchs & Fuchs, 2006).

Students with deficient word identification skills not only receive less practice in reading but soon begin to confront materials that are too difficult for them, which (not surprisingly) results in avoidance of reading. As a consequence, they are prevented from taking advantage of the reciprocally facilitating relationships between reading achievement and other aspects of development, which are referred to as positive (rich-get-richer) Matthew effects (Stanovich, 1986). These developmental spinoffs include vocabulary growth, ability to comprehend more syntactically complex sentences, development of richer and more elaborate knowledge bases, and greater practice opportunities for building fluency and facilitating implicit learning of letter-sound patterns, all of which promote further growth in reading by enabling children to cope with more difficult materials.

As a result of repeated learning failures, many children with dyslexia also develop negative self-perceptions of ability and therefore do not try as hard as other students because of their low expectations of success and poor reading-related self-efficacy. For some of these children, especially boys, the sense of failure and feelings of frustration, coupled with the need to disguise their inability to perform literacy tasks, become so great that they begin to exhibit classroom behavior problems (Prochnow, Tunmer, Chapman, & Greaney, 2001). What began as relatively small differences in reading and reading-related knowledge and skills during the 1st year or so of schooling soon develop into what Stanovich (1986) described as a downward spiral of achievement deficits and negative motivational and behavioral spinoffs (i.e., negative Matthew effects).

Even more damaging to the discrepancy-based approach to identifying children with dyslexia is a considerable amount of research indicating that groups of poor readers formed on the basis of the presence or absence of IQ-achievement discrepancies do not reliably differ in long-term prognosis, response to intervention, or the cognitive skills (e.g., phonemic awareness, phonological recoding) that underlie the development of word recognition (Fletcher, Denton, & Francis, 2005; Fletcher et al., 1994; Francis et al., 2005; Fuchs & Young, 2006; Hatcher & Hulme, 1999; Stanovich & Siegel, 1994; Stuebing et al., 2002; Vellutino, Scanlon, & Lyon, 2000). With regard to response to intervention (RTI), Vellutino, Scanlon, Zhang, and Schatschneider (2008) found in a multi-tiered, longitudinal intervention study that intelligence tests did not reliably distinguish between at-risk children who became independent readers with small-group intervention and those who did not, nor between children who attained grade-level expectations after receiving more intensive, individualized remedial assistance following the small-group intervention and those who did not attain grade-level expectations. However, language-based cognitive measures and measures of incremental growth did distinguish between these groups of struggling readers.

This finding and the finding that nondiscrepancy-defined (i.e., low IQ) poor readers and discrepancy-defined poor readers (i.e., those with IQs in the average to above average range) do not acquire reading skills in a fundamentally different manner suggest that IQ is largely irrelevant to defining dyslexia (Aaron, 1997), other than in applying exclusionary criteria concerning intellectual impairment (see below). In a later section, we argue that the solution to the problem of using the phrase "persistent literacy learning difficulties" is to incorporate empirically supported causal factors of dyslexia into the definition of the condition, factors that would provide the basis for implementing preventive measures not only for students who may be dyslexic but for other target groups as well, such as students with learning difficulties, English language learners, and students from impoverished homes and communities.

Exclusionary Factors

A key aspect of defining dyslexia is saying what it is not. Accordingly, the addition of the second component of our

proposed definition results in dyslexia being defined as persistent literacy learning difficulties (especially difficulties in word recognition, spelling, and phonological recoding) in otherwise typically developing children (i.e., those who do not satisfy standard criteria for exclusion from the diagnosis of dyslexia). Standard exclusionary criteria include conditions that began or existed prior to school entry such as severe attentional problems, mental retardation, oral language impairment, emotional disturbance and/or behavioral difficulties, deficits in hearing or visual acuity, neurological disorders such as autism or childhood schizophrenia, or chronically poor health. Historically, the notion of "unexpected underachievement" has been the central defining feature of dyslexia. Children are identified as having dyslexia only when factors that would be expected to cause problems in all areas of learning, not just reading, are excluded (not ruling out the possibility of comorbidity). For example, children with severe attentional problems would be expected to have problems in all areas of learning, not just reading and writing. Such children should therefore not be diagnosed as having dyslexia. Similarly, children with deficits in auditory acuity due to otitis media (or "glue ear"), for example, would be expected to have trouble with learning in general, because their deficits in auditory discrimination would impede oral language development, which in turn would make understanding classroom instruction in all areas of learning difficult. These examples relate to a core assumption of dyslexia, which is the *assumption of specificity*, the notion that the child diagnosed with dyslexia has a deficit that is reasonably specific to the literacy learning task; that is, the deficits displayed by such children should not extend too far into other areas of cognitive functioning (Stanovich, 1991).

With regard to the exclusionary factor of oral language impairment, because the process of extracting and constructing meaning from text is a language-based skill, reading can be defined as the ability to translate from print to a form of code from which the reader can already derive meaning, namely, the reader's spoken language. Although there are some differences between spoken and written language, comprehending text requires the full set of linguistic skills needed to comprehend spoken language, including locating individual words in lexical memory, determining the intended meaning of individual words (most of which are polysemous), assigning appropriate syntactic structures to sentences, deriving meaning from individually structured sentences, and building meaningful discourse on the basis of sentential meaning. Given that the child's fundamental task in 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 basic ideas are represented in a model of the proximal causes of reading difficulties developed by Gough and Tunmer (1986) called the simple view of reading (SVR). The model makes two claims. First, reading can be decomposed into two components: decoding (or more broadly, word recognition) and oral language comprehension. Second, each of these components is necessary for success in reading, neither being sufficient in itself: The effect of either skill on reading depends on the reader's level of competence in the other skill. That is, $R = D \times C$, where R is reading comprehension, D is decoding skill, and C is oral language comprehension. Thus, if word recognition ability is high but oral language comprehension skill is low, the student will be a poor reader (i.e., if $D = 1.0$, where 1.0 is perfection, and $C = 0$, then $R = 1.0 \times 0 = 0$). If the opposite pattern occurs, where word recognition ability is low but oral language comprehension skill is high, the student will again be a poor reader (i.e., if $D = 0$ and $C = 1.0$, then $R = 0 \times 1.0 = 0$). Stated simply, students who have trouble recognizing the words of (age appropriate) text and/or have trouble understanding the language being read will have trouble understanding the text.

In a recent review of research concerned with the SVR model, Kirby and Savage (2008) concluded that it "provides a good fit to much scientific data on typical and atypical development, and variation among students across the school age range" (p. 75). As a model of the proximal causes of individual differences in reading comprehension performance, the SVR was never intended as a complete theory of the cognitive processes involved in reading. D and C can each be analyzed into component processes (Kirby & Savage, 2008), and the development of each is influenced directly and indirectly by several other factors (e.g., Vellutino, Tunmer, Jaccard, & Chen, 2007). Questions have been raised about whether variation in R can best be fitted as a product ($D \times C$) model or a sum ($D + C$) model (e.g., Georgiou, Das, & Hayward, 2009), but determining which model is more appropriate depends on whether the sample tested represents the full range of scores in D and C or only scores in the middle of these distributions, which are truncated (Kirby & Savage, 2008).

Concerns have also been expressed about how D should be assessed in studies of the SVR (Braze, Tabor, Shankweiler, & Mencl, 2007). Our position is that measures of D in the SVR model should be viewed as developmentally constrained. During the early stages of learning to read, nonword measures of D should probably be used on theoretical grounds, given the crucial role that making use of letter-sound relationships plays in early literacy development. Measures of context free word identification should then be included at somewhat later stages of reading growth to assess the development of word-specific orthographic knowledge. And finally, timed measures of word identification should be included at more advanced stages to capture the development of automaticity in word recognition (i.e., fluency), which is influenced by

print exposure. Using a composite variable derived from all three assessments would probably be the best strategy for many populations.

Kirby and Savage (2008) also make the important point that the contributions of *C* and *D* to the variance in *R* may not be entirely independent. Tunmer and Chapman (1998, 2006) have reported findings that suggest that deficiencies in syntactic knowledge impair the development of word identification skills in students by limiting their ability to use sentence context as an aid to identifying partially decoded words, irregularly spelled words, or words containing polyphonic or orthographically complex spelling patterns. The use of sentence context to confirm hypotheses about what unknown words might be, based on incomplete information from partial decoding attempts, results in correct word identifications, which in turn facilitates the development of beginning readers' word-specific knowledge from which additional spelling-sound correspondences can be induced.

Relatedly, Nation and Snowling (1998) found that poor comprehenders were significantly less accurate at reading exception words than skilled comprehenders, despite the two groups being matched for phonological decoding (nonword reading) and nonverbal reasoning scores (see Ricketts, Nation, & Bishop, 2007, for a recent replication). They argued that poor comprehenders' difficulty with reading exception words is a manifestation of their underlying vocabulary weaknesses. Students with poorly developed vocabulary knowledge will have trouble identifying and assigning appropriate meanings to unknown printed words, especially partially decoded or irregularly spelled words, if the corresponding spoken words are not in their listening vocabulary or are only weakly represented in their mental lexicon. This account may provide an explanation for the recent finding reported by Braze et al. (2007) that vocabulary knowledge among struggling young adult readers is more strongly predictive of reading comprehension than of speech comprehension. Vocabulary knowledge may influence *R* not only directly but also indirectly through its influence on *D*.

Braze et al. (2007) further reported that vocabulary knowledge made an independent contribution to variance in *R* beyond that made by *D* and *C*. They interpreted their findings as pointing to a possible shortcoming of the SVR model, stating that according to SVR, "the effects of oral vocabulary knowledge should be entirely subsumed by general language comprehension" (p. 229). However, in considering this possibility, it is important to distinguish between conceptual issues and measurement issues. As Kirby and Savage (2008) pointed out, "oral language comprehension represents all of verbal ability, including vocabulary, syntax, inferencing and the construction of mental schemas" (p. 76). For example, vocabulary knowledge alone would not be a satisfactory measure of *C* because to understand a language is to understand the sentences of the language, not just the words (i.e., knowledge of the language's syntax is necessary). But by the same reasoning, a measure of *C* may not be an adequate measure of vocabulary knowledge if the assessment focuses more on measuring the comprehension of sentences of increasing syntactic complexity rather than on understanding sentences containing increasingly difficult vocabulary items. If it were possible to develop a fully comprehensive measure of *C* that was maximally sensitive to vocabulary knowledge as well as all the other components of *C*, we could test Kirby and Savage's (2008) claim concerning the lack of independence of *C* and *D* in the SVR model.

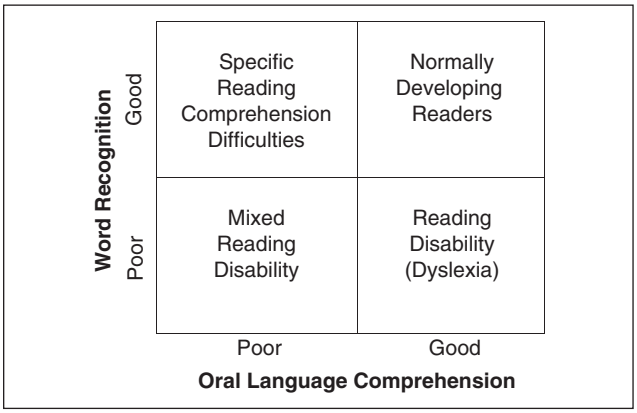

Figure 1. Classification of different categories of reading difficulty according to a model of the proximal causes of reading difficulties
Note: The lines separating the three subtypes of reading difficulty are for representation purposes only, as the two variables that differentiate the subtypes are continuous, not dichotomous.

An important feature of the SVR model is that it provides a framework for conceptualizing three broad categories of reading difficulties (Aaron, Joshi, Gooden, & Bentum, 2008; Aaron, Joshi, & Williams, 1999; Gough & Tunmer, 1986; Joshi, 2004; Tunmer & Hoover, 1992). The model predicts that reading comprehension problems can result from weaknesses in recognizing printed words, weaknesses in comprehending spoken language, or both (see Figure 1). Students who can understand (age appropriate) text when it is read aloud to them but who experience severe difficulties in learning to decode words even after receiving evidence-based instruction and intervention are referred to as *dyslexics*; students who can read words accurately but have difficulty constructing the meaning of text are described as having *specific reading comprehension difficulties* (Nation, 2005); and students who have problems in both word recognition and oral language comprehension are described as having a *mixed reading disability* (Catts & Kamhi, 2005) and are also known as *garden-variety poor readers* (Gough & Tunmer, 1986).

The language-based deficits that contribute to developmental reading problems vary across the three subtypes of reading difficulties. Each subtype therefore requires a different intervention strategy. In the SVR framework, dyslexia

is characterized as a discrepancy between reading comprehension and oral language comprehension rather than as a discrepancy between reading comprehension and IQ. The condition is generally associated with problems in the phonological domain (Catts & Kamhi, 2005; Snowling, 2000; Vellutino & Fletcher, 2005; Vellutino, Fletcher, Snowling, & Scanlon, 2004), especially deficiencies in phonemic awareness (the ability to segment spoken words into phonemic elements) and phonological recoding. Both abilities are crucial for the development of word reading skills. As predicted by the model, the development of adequate facility in word identification is a necessary (although not sufficient) condition for the development of reading comprehension ability. Growth in the ability to construct meaning from text will therefore be impeded if children fail to develop the phonemically based skills necessary for constructing adequate word-level representations.

Research has established that making use of letter-sound relationships to identify unfamiliar words is the basic mechanism for acquiring word-specific knowledge (i.e., knowledge of specific letter sequences), including knowledge of irregularly spelled words. Taking advantage of the systematic mappings between subcomponents of written and spoken words enables beginning readers to identify unknown words, which in turn results in the formation of sublexical, visuophonological connections between printed words and their spoken counterparts in lexical memory. This process provides the basis for constructing the detailed orthographic representations required for the automatization of word recognition (or what Ehri, 2005, calls *sight word* knowledge), thus freeing up cognitive resources for allocation to sentence comprehension and text integration processes (Pressley, 2006).

As the reading attempts of beginning readers with a firm understanding of the alphabetic principle become more successful, they will begin making greater independent use of letter-sound information (possibly supplemented with sentence context cues) to identify unfamiliar words in text. Phonologically recoding words a few times ultimately cements their orthographic representations in lexical memory from which additional spelling-sound relationships can be induced without explicit instruction (Snow & Juel, 2005; Tunmer & Nicholson, in press). However, for children encountering difficulty in developing the ability to perceive intuitively the redundant patterns and connections between speech and print, explicit instruction in alphabetic coding skills is likely to be crucial (Ryder, Tunmer, & Greaney, 2008).

To discover mappings between spelling patterns and sound patterns, children must be able to segment spoken words into subcomponents. Children who experience ongoing difficulties in detecting phonemic sequences in words (i.e., phonemic awareness) will not be able to fully grasp the alphabetic principle and discover spelling-to-sound relationships (Shankweiler & Fowler, 2004). Without specific intervention, the development of word recognition skill in these children will be impaired. Stanovich (1996) succinctly described the causal chain of events leading to developmental dyslexia: "Impaired language segmentation skills lead to difficulties in phonological coding which in turn impede the word recognition process which underpins reading comprehension" (p. 155). Systematic reading interventions involving dyslexic children have therefore targeted phonological awareness and alphabetic coding skills (Torgesen, 2004, 2005).

The classification framework specified by the SVR also includes poor readers with mixed reading disability. These children, who are the majority of poor readers, have more widespread language impairments than are typically found among children with dyslexia (Catts & Kamhi, 2005; Tunmer & Chapman, 2007). In addition to phonological processing deficits, children with mixed reading disability have impairments in vocabulary, morphology, syntax, and/or discourse-level processing, all of which make constructing meaning from text more difficult. Students with limited vocabulary knowledge and/or deficiencies in syntactic knowledge (i.e., implicit knowledge of rules specifying structural relationships in sentences) will have difficulty understanding written sentences, and students who have problems in relating the meaning of each new sentence in spoken discourse to the meanings of the sentences that preceded it (i.e., discourse processing) will have difficulty in comprehending and recalling written stories and passages.

Weaknesses in oral language comprehension therefore place an upper limit on reading comprehension, which would account for research showing that in addition to phonological factors (e.g., phonological awareness), nonphonological oral language factors (e.g., expressive vocabulary, sentence or story recall) are predictive of long-term reading outcomes (Leach, Scarborough, & Rescorla, 2003; Scarborough, 2005). It would also explain why preventive intervention programs for at-risk students with mixed deficits focusing mostly on phonemic awareness and phonemically based decoding strategies initially show positive effects on reading achievement (typically word reading) but fail to maintain these positive effects in later grades when reading comprehension measures are used. This pattern occurs because as reading materials become more advanced in components of language that are common to both oral language comprehension and reading comprehension (e.g., semantics, syntax, pragmatics), the role of broad verbal ability in accounting for reading comprehension difficulties becomes larger (Torgesen, 2004).

Although both dyslexic poor readers and children with mixed reading disability have weaknesses in the phonological domain, the more widespread oral language impairments of the mixed disabled readers further impede the development of their phonemic awareness and phonological recoding skills in at least three ways. First, vocabulary growth during the preschool years plays a major role in the development of

preliterate phonological sensitivity by causing lexical representations to become more segmental (Carroll, Snowling, Hulme, & Stevenson, 2003). Because deficiencies in vocabulary growth are accompanied by more poorly specified phonological representations of spoken words, the development of phonemic awareness is likely to be more severely impaired in children with poorly developed vocabulary knowledge at school entry. Second, children with poorly developed vocabulary knowledge will have trouble identifying and assigning appropriate meanings to unknown printed words, especially partially decoded or irregularly spelled words, if the corresponding spoken words are not in their listening vocabulary (Ricketts et al., 2007). This in turn will limit the development of their phonological recoding skills, as additional spelling-sound relationships can be induced from words that have been correctly identified. Third, as noted previously, deficiencies in syntactic knowledge will impair the development of word identification skills in children with mixed reading disability by limiting their ability to use sentence context as an aid to identifying partially decoded words, irregularly spelled words, or words containing polyphonic or orthographically complex spelling patterns (Tunmer & Chapman, 1998, 2006).

Given these considerations, a prediction that follows from the classification scheme derived from the SVR is that children with mixed reading disability should show greater phonological processing deficits than dyslexic poor readers at the beginning of school and during the early stages of learning to read. In support of this claim, Tunmer and Chapman (2007) found in a longitudinal study of language-related differences between mixed disabled readers and dyslexic poor readers that in addition to the expected differences on oral language measures, the mixed disabled readers also showed consistently greater phonological processing deficits than the dyslexic poor readers across a range of phonological processing measures (see Snowling, Gallagher, & Frith, 2003, for similar findings). These findings and those discussed earlier (Leach et al., 2003; Scarborough, 2005; Torgesen, 2004) suggest that for mixed disabled readers, which constitute by far the largest group of poor readers, early intervention programs need to focus on improving these children's oral language skills as well as their phonological skills (Gersten & Dimino, 2006).

In addition to dyslexic poor readers and mixed disabled readers, the third broad category of disabled readers specified by the SVR model comprises children with specific reading comprehension difficulties. These poor readers are generally free of phonological processing deficiencies and demonstrate satisfactory alphabetic coding skills but (like the poor readers with mixed reading disability) show weaknesses in vocabulary, morphology, syntax, discourse-level processing, and/or comprehension strategies, which in turn negatively affect reading comprehension performance (see Nation, 2005, for a review of research). However, the developmental mechanism responsible for the oral language impairments in children with specific reading comprehension difficulties (excluding hyperlexics and second language learners) may differ from what causes such impairments in children with a mixed reading disability (hyperlexia is typically associated with autism and refers to children who can decode words from a very young age but whose comprehension of both written and spoken language is very poor; Aaron, Joshi, & Quatroche, 2008).

For children with mixed reading disability, oral language impairments stem primarily from limited access to linguistic and environmental opportunities during the preschool years. However, for children with specific reading comprehension difficulties, such impairments appear to be largely a consequence of having substantially less reading and reading-related experience than typically developing readers, which ultimately produces negative Matthew effects in reading (Nation, 2005). As Nation argued, "Poor comprehenders may read less, and learn less from their reading experiences than their peers; therefore impacting on subsequent reading and learning opportunities over time and leading to the formation of weak 'intellectual habits'" (p. 264). Intervention programs for children with specific reading comprehension difficulties may therefore need to focus particular attention on motivating these children to increase both the amount and range of their personal reading.

Exposure to Evidence-Based Instruction and Intervention

In the preceding section, we described children with dyslexia as students who understand text when it is read aloud to them but who experience severe difficulties in learning to decode words even after receiving evidence-based instruction and intervention. The inclusion of this third component in our proposed definition leads to dyslexia being defined as persistent literacy learning difficulties (especially difficulties in word recognition, spelling, and phonological recoding) in otherwise typically developing children (i.e., those who do not satisfy standard criteria for exclusion from the diagnosis of dyslexia) despite exposure to high quality, evidence-based literacy instruction and intervention.

A major shortcoming of the standard discrepancy-based, definition-by-exclusion approach to identifying children with dyslexia is the implicit assumption that poor literacy achievement reflects disability rather than poor or inadequate teaching when the latter is more often than not the primary contributing factor (Fuchs & Fuchs, 2006; Tunmer & Chapman, 1996; Vellutino et al., 1996; Vellutino, Scanlon, Small, & Fanuele, 2006). Vellutino et al. (2006) argued that because discrepancy-based, definition-by-exclusion approaches "do not control for the child's preschool and educational history, they do not adequately distinguish between reading difficulties caused primarily by experiential and instructional deficits and reading difficulties caused primarily by biologically based deficits in

reading-related cognitive abilities" (p. 157). As a consequence, the number of children classified as having dyslexia is highly inflated.

Vellutino and colleagues (Vellutino, Scanlon, & Jaccard, 2003; Vellutino et al., 1996) investigated the extent to which experiential/instructional deficits are primary causes of early and protracted reading difficulties, especially for children who have acquired such limited amounts of crucial reading-related knowledge, skills, and experiences (e.g., letter-name knowledge, phonological awareness, knowledge of "book" or "decontextualized" language, invented spelling ability, understanding of the concepts and conventions of printed language, etc.) from home and preschool that they are unable to acquire basic literacy skills by means of regular classroom instruction without additional support. Vellutino and colleagues carried out a longitudinal study in which a large sample of children was tracked from the beginning of kindergarten to the end of third grade. The children who had significant reading problems by the middle of first grade (approximately 9% of their sample) were provided with one-to-one remedial instruction during the second semester of first grade. Vellutino et al. (1996) found that 67% of these children (the "readily remediated poor readers") were within the normal range of reading achievement following the remediation. In addition, these children performed significantly better than the "difficult-to-remediate poor readers" (i.e., those who did not respond to the intervention) on measures of phonological processing administered prior to the intervention. Vellutino and colleagues concluded from these results that most children with early reading difficulties suffer from experiential and instructional deficits and that the truly disabled readers (1.5% of the sample) are those children with relatively severe phonological processing deficits who, as a consequence, do not respond to either regular classroom instruction or intensive, short-term intervention efforts.

Emerging from these findings and those of others is the RTI approach to preventing and identifying reading disability (Deshler, Mellard, Tollefson, & Byrd, 2005; Fuchs & Fuchs, 2006). Earlier, we drew attention to the inseparability of the questions of what dyslexia is, what causes it, and what can be done about it. RTI simultaneously addresses all three questions by defining reading disability/dyslexia as the inability of otherwise typically developing children (i.e., those who do not satisfy standard exclusionary criteria) to *respond* adequately to high quality instruction/intervention because of an impairment in the phonological processing skills required to learn to read. The RTI model includes procedures for identifying reading disability, for closely monitoring progress in acquiring the word identification and text comprehension skills and strategies known to be causally related to early reading development, and for implementing research-based secondary and tertiary interventions for children with persistent literacy learning problems.

RTI operationalizes unexpected underachievement in terms of both low performance on reading and reading-related measures and poor response to high quality instruction. This "dual discrepancy" assessment procedure provides the basis for the early identification of students at risk for reading failure. In assessing response to instruction, intervention serves as the "test stimulus" and rate of growth (i.e., degree of responsiveness to intervention) serves as the "test performance" in identifying reading disability (Fuchs & Fuchs, 2006, p. 95). RTI uses evidence-based instruction and continuous progress monitoring across multiple tiers (usually three) to provide early intervention for children at risk for reading failure and to develop a more reliable procedure for identifying students with reading disability. Only at-risk students who show little or no progress in reading performance after exposure to multiple tiers of intervention are considered as likely candidates for being classified as students with dyslexia in need of continued services. Following this procedure makes it possible to identify students for whom the core phonological deficit is most likely biological rather than environmental.

The first tier of RTI models typically involves "enhanced classroom instruction" (Denton & Mathes, 2003, p. 233) where literacy teaching in the earliest years of school addresses the individual needs of all of the children in the classroom, especially those experiencing early literacy difficulties. In this approach, teachers use research-based assessment procedures and instructional strategies to cater to the differing skill needs of beginning readers from the outset of schooling, with particular attention focused on ensuring the development of phonemic awareness and phonemically based decoding skills by all children during the early stages of reading acquisition. Using a model similar to the SVR, Aaron, Joshi, Gooden, and Bentum (2008) reported evidence supporting an approach to the differential diagnosis and treatment of early reading difficulties in which children are identified as having reading problems relating mostly to comprehension processes, mostly to decoding processes, or to both components of reading. Wagner (2008) recommended incorporating into the RTI approach an initial evaluation consisting of measures of emergent literacy (e.g., phonological processing, print awareness) that are known to be predictive of reading performance.

The second tier of RTI models normally involves more explicit and extended (small group) instruction for children whose rates of progress in the first tier identify them as at risk for reading difficulties and in need of supplemental instruction (i.e., secondary intervention). Children who continue to progress at a very slow rate after the provision of second-tier supplementary instruction are placed in more intensive third-tier interventions (e.g., daily one-to-one tutoring) of longer duration (see Denton & Mathes, 2003, for a more detailed discussion of the three-tier model). Continuous monitoring of individual student progress is used in each of the three tiers to determine whether a child no longer needs supplemental instruction, needs continuing support at the existing level, or is eligible for a higher level of support.

A major advantage of the RTI approach is that it provides the basis for differentiating the intensity of instruction to improve educational outcomes for all at-risk and struggling readers, thus avoiding the all-or-nothing nature of many remedial programs, such as RR, where a poor reader either qualifies for additional assistance or does not. Because at-risk and struggling readers are already behind in the development of reading and reading-related skills, they must improve their reading skills at a faster rate than their typically achieving peers to close the gap in literacy achievement (Torgesen, 2004). To achieve this outcome, preventive and remedial instruction must be more intense than regular classroom instruction. Intensity can be increased by reducing group size, increasing intervention duration, increasing session frequency, increasing session time, or some combination of these approaches (Vaughn & Linan-Thompson, 2003; Wanzek & Vaughn, 2008). Further research is required to determine which approach, or combination of approaches, to increasing the intensity of instruction for struggling readers is most effective (Wanzek & Vaughn, 2008).

An important aim of the RTI model is to increase the accuracy of selecting children who are truly in need of secondary intervention (i.e., "true positives") to ensure that the most vulnerable children receive supplemental instruction, thus preventing the development of more significant reading problems (Fuchs & Fuchs, 2006). Two types of errors can lower the degree of accuracy in identifying at-risk students: false positives and false negatives. Selecting students for intense services who are not in need of them results in false positives, which undermines the effectiveness of RTI models by inflating the number of at-risk children and putting under stress the resources available for secondary interventions. False negatives occur when children score above the cut-off scores on predictive measures but later develop reading difficulties. A high number of false negatives diminishes the preventive aspect of RTI models by depriving at-risk children of the additional support that they require. A related issue is the question of how *nonresponsiveness* to secondary intervention should be defined, that is, how should *reading disability* or *dyslexia* be defined within the RTI framework for whatever official purposes such classification is needed? Progress in addressing these issues has been reported in recent studies by Fuchs, Compton, Fuchs, Bryant, and Davis (2008) and Vellutino et al. (2008). Of particular importance is the finding that RTI-based procedures yielded false positive rates for inclusion in secondary interventions of less than 10%, which compares very favorably with other second-tier interventions like Reading Recovery, which appears to have a false positive rate of around 30% (Center, Wheldall, Freeman, Outhred, & McNaught, 1995).

Research on RTI is ongoing and a variety of multi-tiered, RTI models are currently being investigated (Al Otaiba & Fuchs, 2006; Chard & Linan-Thompson, 2008; Denton, Fletcher, Anthony, & Francis, 2006; McMaster, Fuchs, Fuchs, & Compton, 2005; O'Connor, Fulmer, Harty, & Bell, 2005; Vaughn, Linan-Thompson, & Hickman, 2003; Vellutino et al., 2006). However, concerns have been raised about the reliability of identifying reading disability based on the RTI approach because of variability in the way in which RTI models are being implemented (Berkeley, Bender, Peaster, & Saunders, 2009) and variability associated with teacher quality and differential effectiveness in both regular classroom instruction (first tier) and the secondary intervention (Wagner, 2008). Although acknowledging these concerns, we nevertheless suggest that conceptual issues need to be distinguished from implementation/operational issues in the formulation of a definition of dyslexia. If some notion of the failure to respond to high quality, evidence-based instruction and intervention is not explicitly built into the definition of dyslexia (irrespective of whether or not RTI turns out to be the most feasible approach), it will not be possible to distinguish between poor readers who did not receive adequate instruction and those who are genuinely dyslexic. This is certainly a very real possibility in a country like New Zealand, which for the past two decades has strongly adhered to a constructivist, whole language approach to reading instruction that places heavy emphasis on the use of multiple cues (especially sentence context cues) in learning to read (Tunmer et al., 2003, 2004, 2006; Tunmer et al., 2008; Tunmer & Prochnow, 2009). The advocacy group most responsible for the recent recognition of dyslexia in New Zealand claims that 10% of New Zealand schoolchildren are dyslexic (Dyslexia Foundation of New Zealand, 2008). Although international studies of reading achievement over the past 20 years have consistently shown that New Zealand does indeed have a relatively high proportion of reading failures compared with other countries (see earlier discussion), the majority of these children are most likely "teaching disabled" rather than reading disabled.

Support for the RTI conceptualization of dyslexia comes from recent studies of the neurobiological effects of successful reading interventions for children with severe reading difficulties, especially evidence indicating plasticity in the neurophysiological processes involved in reading. Functional magnetic resonance imaging (fMRI) has been used to study the anatomical distribution of neurophysiological activity during reading before and after remediation of reading impairments by means of interventions focusing on intensive training in phonologically based skills and strategies (Aylward et al., 2003; Shaywitz et al., 2004; Simos et al., 2002; Simos et al., 2007). The most important finding emerging from these studies is that the activation profile of the successfully remediated poor readers becomes much more like the activation profile of normally developing readers and, with the passage of time, increasingly like that of skilled readers.

In neurophysiological terms, these findings suggest that persistent literacy learning problems in otherwise typically developing children are primarily due to the ongoing failure

of the children to deploy the appropriate neurological systems in the brain when confronted with the task of learning to read and write in an alphabetic orthography. In behavioral terms, the literacy learning problems of these children result from the continuing use of ineffective learning strategies, such as attempting to learn new words by relying on partial visual cues (such as the word's shape) and/or partial word-level cues (such as the initial letter of the word) in combination with contextual guessing. However, with the use of appropriate intervention strategies of the kind provided in the third tier of RTI models, many students with persistent reading difficulties can be taught to use their brains in a more effective manner. As Shaywitz (2003) concluded, the results of brain activation studies leave no doubt that "the core problem in dyslexia is phonologic: turning print into sound" (p. 87).

Inclusionary Factors

In the preceding sections, we argued that developmental reading problems in children with dyslexia stem primarily from deficits in phonological processing skills. The addition of this final component to our proposed definition results in dyslexia being defined as persistent literacy learning difficulties (especially difficulties in word recognition, spelling, and phonological recoding) in otherwise typically developing children (i.e., those who do not satisfy standard criteria for exclusion from the diagnosis of dyslexia) despite exposure to high quality, evidence-based literacy instruction and intervention, due to an impairment in the phonological processing skills required to learn to read and write. This aspect of our proposed definition is similar to the definition of dyslexia adopted by the International Dyslexia Association, which states that the literacy learning difficulties of children with dyslexia "typically result from a deficit in the phonological component of language" (Catts & Kamhi, 2005, p. 62). However, we acknowledge that other explanations of dyslexia have been put forward, which is why we indicated at the outset that dyslexia should be viewed as a hypothetical construct embedded within a theory of reading difficulties, a theory that may eventually be rejected by scientific evidence that favors an alternative theory. But, in the interests of scientific parsimony, we believe that the current definition of dyslexia should focus on the causal explanation of the condition for which there is the greatest amount of supportive evidence.

A major shortcoming of the traditional discrepancy-based definition-by-exclusion approach to identifying children with dyslexia is the failure to specify factors known to be causally related to reading difficulties, factors that in turn would provide the basis for early intervention. Given the nature of negative Matthew effects in reading, early intervention that focuses on the phonological core deficit is a more effective strategy for helping children at risk for dyslexia than delaying action until substantial evidence of literacy learning difficulties has accumulated. The longer the delay in providing remedial assistance, the greater the likelihood that reading problems will become severe and difficult to ameliorate. Catts and Kamhi (2005) refer to postulated causes of dyslexia (such as phonological processing deficits) as *inclusionary* factors.

Over the years, many explanations of reading disability have been put forward, only to be later rejected. Vellutino and Scanlon (1982) examined the arguments and evidence in support of theories that attributed persistent reading difficulties to deficits in visual processing, cross-modal transfer, serial memory, attention, association learning, or rule learning and concluded that all of these theories were untenable, due to a lack of supportive evidence and/or the failure to satisfy the assumption of specificity concerning dyslexia (see also Vellutino et al., 2004).

For example, because reading involves the visual modality, it was long thought that the major problem in learning to read was the failure to discriminate the visual representations of language—the letters and printed words. However, studies involving a wide variety of tasks and procedures have shown that visual discrimination is not the central problem that it was once thought to be, as there is little evidence to indicate that good and poor readers of the same general intellectual ability differ in their basic visual information processing skills (Vellutino, 1979). In fact, research has shown that prereaders demonstrate a level of visual competence altogether adequate for reading acquisition and appear to handle graphic symbols with letter-like distinctive features in much the same manner as adults (Calfee, 1977). Moreover, during the initial stages of learning to read, most developing readers go through a brief period during which mirror-image and reversal errors appear in their early attempts to read and spell words. The occurrence of such errors in older students indicates serious delays in reading development, not deficiencies in visual discrimination. That is, for older, struggling readers, making these kinds of errors is a symptom, not a cause, of literacy learning difficulties. More recently, dyslexia has been associated with deficits in the transient visual system (Lovegrove, Garzia, & Nicholson, 1990) and in the perception of visual motion (Eden et al., 1996). However, neither type of low-level visual deficit has been shown to be causally related to reading difficulties (Hulme, 1988; Vellutino et al., 2004).

As noted previously, deficits in phonological processing skills are now widely regarded as the major cause of dyslexia. Phonological processing includes encoding phonological information (phonetic perception); gaining access to and performing mental operations on phonological information (phonological awareness); retrieving phonological information from semantic memory (lexical retrieval); retaining phonological information in working memory (short-term verbal recall); and translating letters and letter patterns into phonological forms (phonological recoding). A considerable amount of research indicates that with very rare exceptions, students

diagnosed with dyslexia have a history of deficits in one or more aspects of phonological processing, especially phonological awareness and phonological recoding (Snowling, 2000; Vellutino & Fletcher, 2005; Vellutino et al., 2004).

Conclusions and Implications

In summary, we have presented arguments and evidence in support of defining dyslexia in terms of four components: (a) persistent literacy learning difficulties (b) in otherwise typically developing children (c) despite exposure to high quality, evidence-based literacy instruction and intervention, (d) due to an impairment in the phonological processing skills required to learn to read and write. In defining dyslexia in this manner, we are not suggesting that children diagnosed as having dyslexia cannot make progress in learning to read. Rather, our claim is that these children require more intensive instruction of longer duration of the kind provided in the third tier of RTI models.

This definition can be contrasted with the working definition of dyslexia developed by the New Zealand Ministry of Education (2008):

> Dyslexia is a spectrum of specific learning difficulties and is evident when accurate and/or fluent reading and writing skills, particularly phonological awareness, develop incompletely or with great difficulty. This may include difficulties with one or more of reading, writing, spelling, numeracy or musical notation. These difficulties are persistent despite access to learning opportunities that are effective and appropriate for most other children.
>
> People with dyslexia can be found across the achievement spectrum and sometimes have a number of associated secondary characteristics which may also need to be addressed, such as difficulties with auditory and/or visual perception; planning and organising; short term memory; motor skills or social interaction.
>
> People with dyslexia often develop compensatory strategies and these can disguise their difficulties. People with dyslexia can also develop compensatory strengths which can provide an opportunity to further advance their learning.
>
> Early identification followed by a systematic and sustained process of highly individualised, skilled teaching primarily focused on written language, with specialist support, is critical to enable learners to participate in the full range of social, academic and other learning opportunities across all areas of the curriculum. (p. 1)

Although the ministry's definition has a number of positive elements, several areas of concern need to be addressed. First, although phonological awareness is mentioned in the definition, the wording gives the impression that phonological awareness is a reading or writing skill when it is neither. Moreover, reference should also be made to phonological recoding (or more broad, phonological processing skills) in the definition, as many children who experience ongoing literacy learning difficulties eventually acquire rudimentary phonological awareness but still show severe deficits in phonological recoding. This is because an initial weakness in phonological awareness will be developmentally limiting if not corrected during the early stages of learning to read (Stanovich, 1986).

Second, the statement that dyslexia includes learning difficulties with *one* or more of reading, writing, spelling, numeracy, or musical notation implies that it is possible for a student to have problems with numeracy or musical notation, but no difficulties in reading, writing, or spelling, yet still be considered as having dyslexia. Such a view is surely incorrect and would not be accepted by the scientific community. Difficulties in numeracy or reading musical notation should not be regarded as core manifestations of dyslexia, as there is no compelling evidence or theoretical arguments that either shares the same underlying causes as reading, writing, and spelling difficulties or that either is strongly, or even weakly, associated with dyslexia.

Third, although other conditions may sometimes co-occur with dyslexia as a direct consequence of difficulties in acquiring literacy skills (such as attentional or behavioral problems), the statement that difficulties with auditory and/or visual perception, planning and organizing, short-term memory, motor skills, or social interaction can be associated secondary characteristics of dyslexia that may also need to be addressed is problematic because all of these postulated secondary characteristics violate the assumption of specificity. As noted earlier, the notion of unexpected underachievement has been the central defining feature of dyslexia, in which case these secondary characteristics would be ruled out. For example, children experiencing difficulty in planning and organizing would be expected to have problems in all areas of learning, not just reading and writing.

In view of these shortcomings in the ministry's working definition of dyslexia, we recommend that the ministry consider adopting the definition that we have proposed.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

Financial Disclosure/Funding

The authors received no financial support for the research and/or authorship of this article.

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