Ann. of Dyslexia (2010) 60:1–17
DOI 10.1007/s11881-009-0031-z

Reading fluency: implications for the assessment of children with reading disabilities

Elizabeth B. Meisinger · Juliana S. Bloom · George W. Hynd

Received: 19 December 2008 / Accepted: 12 October 2009 / Published online: 24 December 2009

Abstract The current investigation explored the diagnostic utility of reading fluency measures in the identification of children with reading disabilities. Participants were 50 children referred to a university-based clinic because of suspected reading problems and/or a prior diagnosis of dyslexia, where children completed a battery of standardized intellectual, reading achievement, and processing measures. Within this clinical sample, a group of children were identified that exhibited specific deficits in their reading fluency skills with concurrent deficits in rapid naming speed and reading comprehension. This group of children would not have been identified as having a reading disability according to assessment of single word reading skills alone, suggesting that it is essential to assess reading fluency in addition to word reading because failure to do so may result in the under-identification of children with reading disabilities.

Keywords Assessment · Dyslexia · Phonological processing · Rapid naming · Reading disability · Reading fluency

Reading fluency is most often defined as the ability to read text quickly, accurately, and with appropriate expression (National Reading Panel, 2000; Kuhn and Stahl, 2004). The development of fluent reading skills is essential for children's academic success. Children are expected to become fluent readers during second and third grades, and by fourth grade children transition from learning how to read to reading to learn new information (Chall,

This project was supported in part by a grant from the National Institute for Child Health and Human Developmental, National Institutes of Health (NICHD/NIH no. 26890-06).

E. B. Meisinger (✉)
University of Memphis, Memphis, TN, USA
e-mail: bmsinger@memphis.edu

J. S. Bloom
The Children's Hospital of Philadelphia, Philadelphia, PA, USA

G. W. Hynd
Arizona State University, Phoenix, AZ, USA

1996). Dysfluent readers, for whom reading is laborious and slow, will likely have difficulty in learning content area knowledge (Chall, Jacobs, & Baldwin, 1990) and may experience general frustration and avoidance of reading (Leinonen, Muller, Leppanen, Aro, Ahonen, & Lyytinen, 2001; Pinnell, Pikulski, Wixon, Campbell, Gough, & Beatty, 1995; Raskinski, 2001). Furthermore, children who read less because of their dysfluency may not improve their skills at the same rate as their more fluent peers (Anderson, Wilson, & Fielding, 1988; Taylor, Frye, & Maruyama, 1990). Importantly, oral reading fluency has been shown to be related to comprehension (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Fuchs, Fuchs, & Maxwell, 1988; Jenkins, Fuchs, Van Der Broek, Epsin, & Deno, 2003a; Nation and Snowling, 1997; Shinn, Good, Knutson, Tilly, & Collins, 1992).

Traditionally, dyslexia has been primarily assessed with measures of single word decoding; however, difficulty with reading fluency has been increasingly acknowledged as a significant aspect of reading disabilities. Reading fluency was added to the federal definition of a specific learning disability in the reauthorization of the Individuals with Disabilities Education Improvement Act (IDEA, 2004). Recent conceptualizations by the International Dyslexia Association (Lyon, Shaywitz, & Shaywitz, 2003) also include reading fluency as an area of difficulty for individuals with dyslexia. One of the most important changes to the definition of dyslexia is the recognition that "what characterizes dyslexic individuals, particularly dyslexic adolescents and adults, is the inability to read fluently" (Lyon et al., 2003, p. 6). This definition refers to the fact that many adult dyslexics experience difficulties with reading fluency even after becoming accurate word readers (Lefly and Pennington, 1991; Shaywitz, 2003). Furthermore, intervention research has shown that it is harder to attain improvements in reading fluency compared to improvements in reading comprehension, decoding, and word identification skills (Lyon and Moats, 1997; Meyer and Felton, 1999; Torgesen, Rashotte, & Alexander, 2001). However, more work is needed to explore reading disability characterized primarily by a lack of fluency (Lyon et al., 2003). Relative to the lack of research regarding reading fluency problems as a disability, its importance in typically developing reading skill is well established (Chall, 1996; Kuhn and Stahl, 2004; Schwanenflugel, Meisinger, Wisenbaker, Kuhn, & Morris, 2006).

Curriculum-based reading fluency probes are frequently utilized in Response to Intervention approaches for assessing reading disabilities, a popular model often used in school settings (Deno, 2003; Stecker and Fuchs, 2000; Wayman, Wallace, Wiley, Ticha, & Espin, 2007). However, more traditional models are typically employed in private clinics, hospitals, and many school settings that use standardized and norm-referenced measures, which may overlook reading fluency. This omission may be due in part to the lack of available standardized and norm-referenced measures of reading fluency (Fuchs et al., 2001). The majority of commonly used tests of broad reading achievement include word identification (i.e., word recognition), decoding (sometimes called, pseudoword reading, phonemic decoding, or word attack), and reading comprehension measures, but seldom include measures of reading fluency (Fuchs et al., 2001). Standard definitions of reading fluency emphasize the fluent oral reading of *large blocks of text* (Kuhn and Stahl, 2004) as opposed to single sentences or words. Although some reading measures are titled "reading fluency," they do not assess reading fluency as it is typically defined. For example, the Reading Fluency subtest in the Woodcock–Johnson Tests of Achievement—Third Edition (Woodcock, McGrew, & Mather, 2001) assesses a child's ability to quickly read simple sentences and decide whether the statements (e.g., *The grass is green.*) are accurate. Although this measure may contribute valuable information regarding a child's general speed of processing or semantic verification processes during a reading task, given the simplicity of the sentences and length of the text, this is not an assessment of reading fluency. To our knowledge, the Gray Oral Reading Test-4 (Wiederholt and Bryant, 2001) is the only commonly used standardized, norm-referenced test of reading fluency currently available for the assessment of children.

The omission of appropriate measures of reading fluency in the assessment of children's reading skills may have important implications for diagnostic decision-making. To comprehend what is read, children must be able to correctly identify words they encounter in text. Yet, even after accounting for word reading, reading fluency has been shown to make unique contributions to reading comprehension (Meisinger, Schwanenflugel, & Woo, 2009; Jenkins et al., 2003a). This suggests that word reading and reading fluency are related but distinct reading skills. Although only a few studies on the identification of reading disabilities have included measures of reading fluency, there is some suggestive evidence that these measures may be more sensitive to detecting reading difficulties than word reading measures (Breen and Drecktrah, 1990; Nation and Snowling, 1997). Moreover, some research suggests that deficits in reading fluency are more difficult to remediate than deficits in comprehension or word-level skills (Lyon and Moats, 1997; Meyer and Felton, 1999; Torgesen et al., 2001). Given that children are expected to be proficient in reading passages and books (in addition to word lists) in the classroom environment, a further argument may be made regarding the ecological validity of reading fluency. In sum, if evaluations of children who are suspected of having a reading disability do not include a measure of reading fluency, misleading conclusions may be drawn regarding the child's reading competencies. Implications for the incorporation of reading fluency into the assessment of reading skills, especially with regard to fluency deficits in the identification of reading disability subtypes, need to be examined (Fuchs et al., 2001; Wolf and Katzir-Cohen, 2001).

Cognitive processes underlying reading disabilities

Consensus exists that phonological processing represents a core deficit in both reading-disabled as well as "garden-variety poor readers" (Fletcher et al., 1994; Liberman and Shankwiler, 1991; Morris et al., 1998; Shankweiler et al., 1995; Stanovich and Siegel, 1994). Mounting evidence suggests that a second core deficit in the processes that underlie naming speed may help to explain reading problems in many children (for a complete review, see Wolf, Bowers, & Biddle, 2000). Although naming speed deficits have been documented in children with reading problems, the independence of the processes underlying naming speed from phonological processes is still debated (Vellutino, Fletcher, Snowling, & Scanlon, 2004). Evidence suggests that naming speed contributes more to word identification skills, while phonological processing makes greater contributions to decoding skills (Wolf, O'Rouke, Gidney, Lovett, Cirin, & Morris, 2002). Children with "double-deficits" in both phonological processing and naming speed are clearly more impaired than those having deficits in only one area (Katzir, Kim, Wolf, Morris, & Lovett, 2008; Wolf and Bowers, 1999; Wolf et al., 2002). Importantly, naming speed deficits have been shown to impact the rate with which individuals are able to read connected text (Bowers, 1993; Breznitz and Berman, 2003; Katzir, Shaul, & Breznitz, & Wolf, 2004; Stage, Sheppard, Davidson, & Browning, 2001; Young and Bowers, 1995) and so has particular implications for reading fluency.

Automaticity theory (LaBerge and Samuels, 1974) offers one framework from which the impact of processing deficits on reading fluency and comprehension may be discussed. This theory holds that as the processes underlying decoding and reading words become automatic, resources are freed to use for higher-level processes such as comprehension. In other words, as children develop proficiency in their word reading skills, they can begin to use their cognitive and attentional resources to make meaningful connections within the text. If deficits in phonological processing or naming speed impede the development of fast and accurate word reading skills, then reading is likely to be slow and dysfluent, leaving fewer cognitive resources available for comprehension. In particular, naming speed seems to be an important factor in reading rate (Bowers, 1993; Breznitz and Berman, 2003; Katzir et al., 2004; Stage et al., 2001; Young and Bowers, 1995). Even after children are able to identify words accurately, slow processing may continue to impede the reading process such that comprehension is adversely affected.

Reading fluency disability subtype

Research on the existence of a reading fluency disability subtype is somewhat inconsistent, with some studies finding support for this construct (Lovett, 1984, 1987; Morris et al., 1998), while another does not (Jenkins, Fuchs, Van der Broek, Epsin, & Deno, 2003b). Specifically, evidence suggests that some children may exhibit specific deficits in reading fluency, such that they are able to recognize and decode words accurately but read connected text at an excessively slow rate (Lovett, 1984, 1987; Morris et al., 1998). Lovett (1984, 1987) argued that reading skills should be assessed in terms of two criteria: accuracy and automaticity. Children were identified by Lovett as “accuracy-disabled” if they were unable to decode words with age-appropriate skill and were characterized by slow and inaccurate reading. Children who could recognize words accurately but who demonstrated deficiency in text reading speed were labeled as “rate-disabled.” When compared to fluent readers who were matched on isolated word recognition skills, the rate-disabled group recognized words more slowly, read connected text less accurately, and exhibited deficits in performing visual naming speed tasks (Lovett, 1987). Further, the rate-disabled group showed no signs of the phonological processing deficits exhibited by the accuracy-disabled group and had better reading comprehension skills. These results suggest that the slow speed of word reading and the processing underlying visual naming speed may interfere with the rate-disabled children’s ability to read connected text.

Morris et al. (1998) used cluster analysis to investigate subtypes of reading disabilities. Of particular interest is that 8% of children qualified for a “rate-deficit” subtype. The rate-deficit subtype was characterized by poor performance on measures of rapid serial naming, nonverbal memory, and production of speech. Importantly for our purposes here, these children demonstrated average decoding, word identification, and comprehension skills, but below average skills in reading fluency. Overall, results from Morris et al. and Lovett suggest that some children experience specific problems in the area of reading fluency and that rapid serial naming may play role in mediating text reading rate.

In contrast, Jenkins et al. (2003b) were not able to identify children who experienced specific deficits in reading fluency. In that study, the reading skills of fourth-grade children identified as reading-disabled or as skilled readers were examined. Children read aloud from a narrative passage and a context-free word list consisting of the words from the narrative passage for one minute each. Skilled readers were found to read the passage and the word list faster and more accurately than their reading-disabled peers. Importantly, all readers who struggled with reading the passage also experienced concurrent difficulties on the word fluency task (i.e., timed context-free word list; Jenkins et al., 2003b). However, evidence suggests that word fluency (i.e., word reading tasks involving both speed and accuracy) may be less distinct from reading fluency (i.e., text reading tasks involving both speed and accuracy) than more traditional measures of word identification (i.e., word reading accuracy; Schwanenflugel et al., 2006; Meisinger et al., 2009). Therefore, it may be that the Jenkins et al. results differed from those of Morris et al. and Lovett because measures of word fluency rather than word reading accuracy measures were used.

Detecting reading problems using reading fluency

To date, only a handful of studies have compared the assessment of reading problems using measures of reading fluency rather than traditional measures of reading skills (i.e., word reading, decoding, and reading comprehension). Breen and Drecktrah (1990) compared the performance of 32 learning disabled children on Kaufman Test of Educational Achievement (KTEA; Kaufman and Kaufman, 1985) and the Gray Oral Reading Test—Revised (GORT-R; Wiederholt and Bryant, 1986). The reading decoding and reading comprehension subtests of the KTEA produced significantly higher standard scores than did the GORT-R Reading Quotient, which combines both reading comprehension and fluency subscales, suggesting that the GORT-R might be more sensitive in detecting reading difficulties than the KTEA. However, because the scores they used conflated reading comprehension with reading fluency (i.e., the GORT-R Reading Quotient combines reading fluency with reading comprehension subtests), it is not clear which skill or skills were responsible for the lower estimates of reading skill observed on the GORT-R reading quotient as compared to the KTEA reading comprehension and decoding subscales.

McCabe, Margolis, and Barenbaum (2001) compared the performance of 34 fourth-grade boys scoring below the 25th percentile on the Iowa Test of Basic Skills on a norm-referenced test of academic achievement, the Woodcock–Johnson Psycho-Educational Battery-Revised (WJ-R; Woodcock and Mather, 1990), and a criterion-referenced informal reading inventory, the Qualitative Reading Inventory-Second Edition (QRI-II; Lesile and Caldwell, 1995). Of the 50% of cases in which the two tests provided different grade level estimates, the QRI provided a lower estimate of children's reading skills for 92% of these. Finally, Sofie and Riccio (2002) contrasted CBM measures of reading fluency with the Passage Comprehension subtests of the Woodcock–Johnson Tests of Achievement—Revised in 40 first and second-grade children. They too found support for the view that reading fluency may differentiate struggling versus typically developing readers.

Purpose of the present study

Some research suggests that reading fluency measures may be more sensitive to detecting reading problems as compared to word-level measures (e.g., Breen and Drecktrah, 1990; McCabe et al., 2001; Sofie and Riccio, 2002), and evidence supports the existence of a reading fluency disability subtype (e.g., Lovett, 1984, 1987; Morris et al., 1998). However, no study to date has directly compared the outcomes of using reading fluency versus word reading measures to assess for the presence of reading disabilities in children across diagnostic models. The primary aim of this study is to fill this gap in the literature by demonstrating the superior diagnostic utility of reading fluency to identify children with reading disabilities.

This research addressed three specific goals: first, to determine whether there are children who have typically developing word identification and decoding skills but who show specific deficits in reading fluency. Second, if such children are identified, to ascertain which cognitive features differentiate children with specific reading fluency deficits from struggling and normal readers. Finally, to investigate whether the omission of reading fluency in the assessment of children referred due to reading difficulties would result in the under-identification of children with reading disabilities.

The current study examined these issues by using a sample of children with dyslexia or suspected of having reading difficulties who were referred to a university clinic for evaluation. If a distinct reading fluency dyslexia subtype exists, we would expect that some children would show typical word reading abilities psychometrically with distinctly poor reading fluency. Children with specific deficits in reading fluency would be expected to show deficits in their rapid naming speed but not phonological processing skills (Lovett, 1984, 1987; Morris et al., 1998) and may be older than students who are struggling with both word and text reading. From a developmental perspective, proficient word reading skills are a necessary prerequisite for fluency at the connected text level (LaBerge and Samuels, 1974).Therefore, readers with a particular deficit in reading fluency would not be discernable until after becoming accurate word readers. Further, because reading fluency is often referred to as the bridge to comprehension (Pikulski and Chard, 2005), it was also expected that children with distinct deficits in reading fluency would experience reduced comprehension compared to their more fluent peers. To this end, children were identified as either normal readers, globally reading impaired, or reading fluency deficit readers. These groupings allowed for comparisons to be made between children with average reading skills (normal readers), those with poor word and text reading skills (globally reading impaired), and those who struggle specifically when reading connected text (reading fluency deficit readers) on measures of phonological processing, rapid naming speed, reading comprehension, and age.

The omission of reading fluency was hypothesized to result in the under-identification of children with reading disabilities. To explore this possibility, two diagnostic models were used to identify children as reading-disabled, the discrepancy and low achievement models. Traditionally, the IQ/achievement *discrepancy model* has been most often used to identify children as having a reading disability, although it has been criticized for being atheoretical (Lyon, 1995) and its validity has been rigorously questioned in the literature (i.e., Fletcher et al., 1994; Stuebing, Fletcher, LeDoux, Lyon, Shaywitz, & Shaywitz, 2002; Vellutino et al., 2000). Another competing model is the *low achievement* or cut score model, where standard scores of 85 or lower are the primary criteria or a reading disability (Fletcher, 1985; Stanovich, 1999), although some also propose exclusionary criteria such as average intelligence (i.e., Dombrowski, Kamphaus, & Reynolds, 2004; Siegel, 1999). It was expected that, regardless of the model applied, a greater number of children would be identified as reading-disabled when reading fluency rather than word-level measures were used.

Method

Participants

Participants were children referred to the Center for Clinical and Developmental Neuropsychology at the University of Georgia to participate in a larger study of familial and neurological features of dyslexia. Families with at least one child between the ages of 8 and 12 who was experiencing reading problems or who had been previously diagnosed with developmental dyslexia were referred to the study through schools, local organizations, and advertisements. Selected participants were children without a history of psychiatric disorders, neurological disorders, severe pre- or perinatal complications, or traumatic brain injury. Previous diagnoses of attention-deficit/hyperactivity disorder (ADHD) were permitted because prior research had demonstrated that, although the disorders are highly comorbid, the cognitive deficits found for those diagnosed with ADHD and RD are distinct (August and Garfinkel, 1990; Shaywitz et al., 1995). Children received a full neuropsychological evaluation consisting of measures designed to assess intelligence, academic achievement, receptive and expressive language, phonological processing, memory, visual-spatial ability, orthographic skills, executive functioning, handedness, exposure to print, and social–emotional functioning. To qualify for inclusion in the current study, a full-scale intelligence quotient within the average range or above (i.e., standard scores >80) and language skills within the normal range (i.e., no diagnosed speech and language impairments) were required.

The demographic make-up of the 50 participants in this sample was as follows: 64% were male, 94% were Caucasian-American, and 6% were African-American. Participants ranged from 8.0 to 12.9 years of age, with a mean of 10.26 (SD=1.38). Although no children in our sample met criteria for ADHD—Hyperactive Impulsive Subtype, 14% were diagnosed with ADHD—Primarily Inattentive Subtype, and 32% of the subjects were diagnosed with ADHD—Combined Subtype. Graduate students in a School Psychology program diagnosed children with ADHD using the criteria outlined in the Diagnostic and Statistical Manual (DSM-IV; American Psychiatric Association, 1994) as well as information obtained from clinical observation, parent rating scales, and teacher rating scales, under the supervision of a licensed psychologist.

Procedure

Families came to the University of Georgia's Center for Clinical and Developmental Neuropsychology to participate in the research study. The parents provided informed, written consent for their own and their child's participation. In addition, the child provided written assent witnessed by their parents. Assessments were completed during the day, with a 1-hour lunch break and additional breaks as needed. In exchange for their participation, parents received a comprehensive neuropsychological report on their child with results reported in a manner useful to school systems for making special education eligibility determinations. All children received a free t-shirt.

Assessments

Measures included in the present study include the Wechsler Abbreviated Scale of Intelligence and selected subtests from the Gray Oral Reading Test—Third Edition, the Comprehensive Test of Phonological Processing, and the Woodcock Reading Mastery Test—Revised.

Intellectual ability The Wechsler Abbreviated Scale of Intelligence (WASI; The Psychological Corporation, 1999) is a brief, standardized, and norm-referenced individually administered test of intellectual ability. The WASI is composed of four subtests: Vocabulary and Similarities create a Verbal Intelligence Quotient and Block Design and Matrices create a Performance (nonverbal) Intelligence Quotient. Together, the four subtests form the Full Scale Intelligence Quotient (FSIQ), which was used in this study as an indicator of general intellectual functioning. The test manual reports reliabilities between 0.95 and 0.97 for the FSIQ and concurrent validity estimates with the WISC-IV of 0.87 for children between the ages of 8 and 16.

Word reading To access children's ability to accurately identify and decode words in isolation (i.e., context-free word reading), the Word Identification and Word Attack subtests of the Woodcock Reading Mastery Tests—Revised (WRMT-R; Woodcock, 1998a, b) were administered. On the Word Identification subtest, children are presented with a list of real words and are asked to read them aloud, whereas on the Word Attack subtest, children are asked to read from a list of nonwords. The two subtests were combined to produce the Basic Reading Skills Composite, which was used as the indicator of word reading skills in the data analysis. The WRMT-R reports internal consistency coefficients ranging from 0.91 to 0.97 on the Word Identification subtest and between 0.89 and 0.90 on the Word Attack subsets for 8- through 12-year-old students. Validity estimates for the Word Identification subtest ranged from 0.82 to 0.74, and for the Word Attack subtest ranged from 0.83 to 0.90 with similar reading measures for 8- through 12-year-old students.

Reading comprehension The Passage Comprehension subtest from the WRMT-R (Woodcock, 1998a, b) was used as a measure of reading comprehension. Children generated an appropriate word to complete a sentence or passage. The test manual reports internal consistency coefficients ranging from 0.68 to 0.92 on the Passage Comprehension subtest and concurrent validity estimates with similar measures between 0.55 and 0.71 (WRMT-R; Woodcock, 1998a, b).

Reading fluency The Gray Oral Reading Test—Third Edition (GORT-3; Wiederholt and Bryant, 1995) is a measure of reading fluency that consists of a series of increasingly difficult passages which the child reads aloud. This test produces several subscales, but the Reading Fluency scale was used for the purpose of this study. A Reading Fluency score is assigned for each passage based on the number of reading errors and time it took the child to read the passage, and these ratings are then summed to form a cumulative Reading Fluency composite score. The GORT-3 provides scaled scores for the Reading Fluency subtest, which have a mean of 10 and a standard deviation of 3, whereas the other measures used produced standard scores with a mean of 100 and a standard deviation of 15. Therefore, a linear transformation was used to convert the GORT-3 Reading Fluency scaled scores to standard scores having a mean of 100 ($SD=15$) to facilitate comparisons across measures. According to the GORT-3 manual, validity estimates for the Reading Fluency scale ranged from 0.34 to 0.82, and reliability estimates ranged from 0.82 to 0.92.

Rapid naming speed The Rapid Naming composite from the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) is a measure of the efficient retrieval of visual and phonological information from long-term memory. The Rapid Naming Composite Score is composed of the Rapid Letter Naming and Rapid Digit Naming subtests. Children are presented with a list of 72 randomly ordered letters and digits, and the time is takes to name these stimuli is recorded for each list. The test manual reports reliabilities of between 0.86 and 0.92 for children ages 7 and older and concurrent validity with various reading measures of between 0.44 and 0.70.

Phonological processing The Elision subtest from the CTOPP (Wagner et al., 1999) was used as a measure of phonological processing. This subtest was selected as previous research demonstrated that the Elision task discriminates between individuals with reading disabilities from normal readers (Lombardino, Riccio, Hynd, & Pinheiro, 1997). The Elision subtest requires children to listen to a string of phonemes such as "m," "o," and "p" and blend them together to create a word "mop." The manual reports reliabilities of between 0.82 and 0.89 and concurrent validity with various reading measures of 0.39 and 0.75.

Reading disability criteria

There has been a great deal of controversy in recent years over the appropriate criteria for diagnosing reading disabilities, with many researchers arguing that the traditional IQ/achievement discrepancy model under-represents children with lower IQ when, in fact, the cognitive deficits found in poor readers are the same regardless of IQ (Stanovich and Siegel, 1994), and IQ does not influence response to intervention (Vellutino et al., 1996). Therefore, two models were used to identify children as reading-disabled: (a) the *discrepancy model* which required a difference of greater than 15 standard score points between the child's FSIQ as measured by the WASI and reading achievement and (b) the *low achievement model* that required below average reading achievement (standard scores <85).

Results

Descriptive statistics

Means for the reading achievement measures fell in the low average to below average range, as would be expected in a clinical sample of children referred due to suspected reading difficulties. Full Scale IQ as measured by the WASI ranged from 83 to 141 standard score points and with a mean of 101.64 (SD=11.24). Children performed best on reading comprehension as measured by the WRMT-R (M=93.08, SD=10.06), followed by decoding as measured by the WRMT-R Word Attack subtest (M=92.70, SD=11.03), then word recognition as measured by the WRMT-R Word Identification subtest (M=90.38, SD=10.20), whereas the lowest score was observed on reading fluency as measured by the GORT-3 Reading Fluency Composite Score (M=81.70, SD=14.16). Processing measures followed a similar pattern. An average score of 87.35 was found for the Phonological Processing composite (SD=13.47), and an average score of 91.46 was found for the Rapid Naming composite (SD=15.53). Table 1 shows correlations among the various measures.

Reading fluency deficit

Children were identified as having a specific deficit in reading fluency (i.e., poor reading fluency but otherwise adequate basic reading skills) if the following criteria were met: (a) at least average word reading skills (i.e., standard score of 85 or greater on the WRMT-R Basic Reading Skills Composite), (b) below average reading fluency skills (i.e., standard score below 85 on the GORT-3 Reading Fluency Composite Score), and (c) a minimum difference of 15 standard score points (or one standard deviation) between reading fluency

Table 1 Correlations among the reading skills (N=50)

	1	2	3	4	5	6	7
Reading fluency (GORT-3)	–						
Word reading (WRMT-R)	0.77**	–					
Decoding (WRMT-R)	0.66**	0.86**	–				
Comprehension (WRMT-R)	0.70**	0.77**	0.63**	–			
Naming speed (CTOPP)	0.62**	0.53**	0.44**	0.48**	–		
PP (CTOPP)	0.43**	0.65**	0.66**	0.58**	0.36*	–	
Age	−0.16	−0.27	−0.26	−0.07	−0.17	−0.25	–

*p<0.05; **p<0.01

PP phonological processing

and their other basic reading skills (i.e., word identification and decoding). The use of a buffer zone is thought to “mitigate some of the arbitrariness of a cut score” approach (Shankweiler, Lundquist, Katz, Stuebing, & Fletcher, 1999, p.75) and has been used by other researchers when dividing children into groups based on their reading profile (e.g., Jenkins et al., 2003b). Using these criteria, 12 out of 50 children (24%) were identified as having a specific deficit in reading fluency. For these 12 children a mean difference of 20.50 standard score points (SD=7.79) was found between children’s word reading skills and reading fluency skills.

It has been shown that children with specific deficits in reading fluency exist in this sample; however, the cognitive processes that differentiate these children from those that struggle with word-level reading or have normal reading skills is unclear. The literature suggests that rapid naming speed, phonological processing, and age may play a role in mediating text reading rate, and consequently that these variables may differentiate reading fluency deficit readers from children with normal reading skills. Thus, we examined rapid naming speed, phonological processing, and age across the groups. Given that comprehension is the primary aim of reading, children’s comprehension skills were also examined. To better understand the profile of the reading fluency deficit group, 23 children with normal reading skills (children with standard scores of 85 or greater on word reading and reading fluency measures) and nine children with globally impaired reading skill (children with standard scores below 85 on all reading fluency and word reading measures) were identified, leaving six students that did not meet the criteria for any group who were excluded from the analysis. Means and demographics for each reading group are displayed in Table 2.

To determine whether the reading fluency deficit group may have unique cognitive deficits that may contribute to their unusually low reading fluency, a series of one-way ANOVAs was conducted to examine the relationship between reading group (i.e., reading fluency deficit, globally reading impaired, and normal reader) and rapid naming speed, phonological processing, age, and reading comprehension. A main effect was found for reading groups on rapid naming speed, F (2, 41)=7.36, p<0.01, partial η^2=0.26. Tukey post hoc comparisons indicated that both the reading fluency deficit (p<0.01) and globally reading impaired reader group (p<0.01) demonstrated slower rapid naming speed compared to normal readers; however, reading fluency deficit and globally impaired readers did not differ from one another on this measure (p>0.05). A main effect was also found for reading groups on phonological processing, F (2, 41)=4.93, p<0.05, partial η^2=0.19. Although Tukey post hoc comparisons revealed that the globally impaired readers had significantly

Table 2 Descriptive statistics for reading groups (N=44)

	RFD (n=12)			GI (n=9)			NO (n=23)		
	M	SD	Range	*M*	SD	Range	*M*	SD	Range
Reading fluency (GORT-3)	70.00	8.53	25	66.10	6.00	20	94.77	6.89	20
Word identification (WRMT-R)	89.17	6.22	22	76.44	6.43	19	97.05	8.47	32
Decoding (WRMT-R)	91.25	6.48	23	79.67	8.22	21	98.64	10.86	44
Comprehension (WRMT-R)	90.58	9.58	34	80.11	4.68	14	98.77	6.42	22
Rapid naming (CTOPP)	84.75	9.78	30	82.89	13.65	43	100.14	14.15	54
PP (CTOPP)	87.08	12.33	35	76.11	8.94	30	92.17	14.85	65
Age	10.35	1.46	4.5	10.62	1.54	5.0	9.87	1.67	3.92
Gender (male)	83%			77%			50%		
Race/ethnicity (Caucasian)	100%			84.6%			95%		

RFD reading fluency deficit, *GI* globally impaired, *NO* normal readers, *PP* phonological processing

lower phonological processing skills than normal readers ($p<0.05$), no difference was observed between the reading fluency deficit and either the globally reading impaired ($p>0.05$) or normal readers ($p>0.05$) in this area.

With regard to reading comprehension, a main effect was found for reading group, F (2, 41)=22.35, $p<0.001$, partial $\eta^2=0.53$. Tukey post hoc comparisons revealed that globally impaired readers comprehended significantly less of what was read than the reading fluency deficit readers ($p<0.001$), who in turn comprehended less than the children with normal reading skill ($p<0.001$). In other words, the broader the impairment across children's word reading and reading fluency skills, the more adversely comprehension was affected. Children's age was not found to vary across reading groups, F (2, 41)=1.23, $p>0.05$, partial $\eta^2=0.06$.

In sum, approximately 24% of the children in this clinical sample showed skill deficits when asked to read aloud from connected text but did not experience concurrent difficulty accurately reading single words presented in isolation or in decoding unknown words. In comparison to normal readers, children with these reading fluency deficits demonstrated slower rapid naming speed and comprehended less of what they read. In contrast, the globally impaired readers exhibited deficits in both rapid naming speed and phonological processing as compared to normal readers and experienced greater difficulties with comprehension than either the reading fluency deficit or normal readers.

Diagnostic implications

The primary aim of this study was to investigate the utility of reading fluency in the identification of children with reading disabilities. Specifically, it was hypothesized that the omission of reading fluency from a psychoeducational assessment would result in the under-identification of children with reading disabilities. To investigate this possibility, two criteria were used to identify children as reading-disabled, the *discrepancy model* and the *low achievement model*. The discrepancy model was first applied using the WRMT-R Basic Reading Skills Composite and the WASI FSIQ standard scores; 30% of the sample was identified as reading-disabled (see Table 3). Next, the discrepancy model was applied to the

Table 3 Low achievement and discrepancy models (N=50)

	Reading fluency (GORT-3)	Basic Reading Skills Composite (WRMT-R)
Discrepancy		
Reading-disabled	33	15
Not reading-disabled	17	35
Low achievement		
Reading-disabled	27	10
Not reading-disabled	23	40

The WRMT-R Basic Reading Skills Composite is comprised of the Word Identification and Word Attack subtests

GORT-3 Reading Fluency Composite Score, and an additional 36% of the sample was identified as reading-disabled. Similar results were observed when the low achievement model was utilized. When the WRMT-R Basic Reading Skills Composite was used, 20% of the sample was identified as reading-disabled, whereas an additional 34% was identified using the GORT-3 Reading Fluency scores as a measure of reading skill. Regardless of the model used, nearly twice as many children were identified as reading-disabled when using the reading fluency measures as compared to use of word reading measures. Further, every child identified as reading-disabled based on their word reading scores also met criteria for a reading disability based on their reading fluency scores, regardless of the model used. Had the reading disability criteria not been first applied to the word reading scores, then those children still would have been identified as reading-disabled based on their reading fluency scores. These results suggest that reading fluency measures capture children with word reading difficulties, but that word reading measures do not necessarily capture children who are struggling with reading connected text.

Discussion

Our results add to the growing body of evidence that reading fluency measures are more sensitive in detecting reading problems than word reading measures (e.g., Breen and Drecktrah, 1990; McCabe et al., 2001; Sofie and Riccio, 2002). Consequently, it is essential to evaluate reading fluency when assessing children referred for reading difficulties, as failure to do so may result in the under-identification of children with reading disabilities. Consistent with previous research our results support the identification of a subgroup of children who exhibit specific deficits in reading fluency without concordant deficits in word reading (Lovett, 1984, 1987; Morris et al., 1998) and also suggest that rapid naming speed is an underlying process that plays an important role in determining the rate at which children read connected text.

To our knowledge, this is the first study to directly compare the diagnostic outcomes of using reading fluency versus word reading measures to identify children as reading-disabled. As hypothesized, the omission of reading fluency resulted in the under-identification of children with reading disabilities in our sample. Regardless of the diagnostic model applied, approximately twice as many children were identified as reading-disabled when reading fluency measures rather than word-level measures were used. These findings have direct clinical implications for the assessment of reading disabilities, suggesting that a psychoeducational assessment that does not assess reading fluency is at risk of under-identifying children who are, in fact, reading-disabled.

Three reading groups were identified as part of this study: a normal reader group, a globally reading impaired group, and a reading fluency deficit group. Our results regarding the reading fluency deficit group were largely consistent with that of previous research (Lovett, 1984, 1987; Morris et al., 1998). Compared to children with normal reading skills, children with specific deficits in reading fluency were characterized by deficits in rapid naming speed but not in phonological processing. These findings suggest that rapid naming speed may be an important variable for explaining difference between the reading fluency deficit children and normal readers. However, the moderate effect size (partial $\eta^2=0.26$) for rapid naming speed suggests that other factors may also be involved. Our most impaired readers, the globally reading impaired group, were characterized by dual deficits in phonological processing and rapid naming speed, which is consistent with other research demonstrating that dual processing deficits result in greater reading impairment than deficits in a single area (Katzir, Kim, Wolf, Morris, & Lovett, 2008; Wolf and Bowers, 1999; Wolf et al., 2002). Reading comprehension varied across the reading groups. Normal readers demonstrated average comprehension, globally impaired readers demonstrated below average comprehension, and children with distinct deficits in their reading fluency had low average comprehension, which fell between the scores earned by the normal and globally impaired readers. As predicted, children with distinct deficits in reading fluency experienced reduced comprehension compared to their more fluent peers. Further, the globally impaired readers experienced the greatest impairment in comprehension, which points to the detrimental effects of dual processing deficits on children's reading skills.

Some developmental trends were anticipated. Given that proficient word reading skills are necessary for reading fluency at the connected text level (LaBerge and Samuels, 1974), it seemed reasonable that younger, struggling readers would be more likely to fall in the globally impaired group (i.e., those who struggle with both word reading and reading fluency). Conversely, children with specific reading fluency deficits were expected to be older than globally impaired readers, as older children should have developed greater facility at the word level but may struggle with connected text. However, children's age was not found to vary across the reading groups. Our findings support the notion that, regardless of age, some children struggle specifically with reading connected text. Still, it is possible that sufficient variation did not exist in children's age to properly explore developmental trends (children in this study ranged from 8 to 12 years of age).

Several limitations of the current study warrant discussion. First, this study reflected the size of the problem in a largely white, clinical sample with children who were referred on the basis of having a previously diagnosed reading disability or a suspected reading problem. While such a sample has its advantages, it also has disadvantages in terms of learning the relative incidence of reading fluency issues. For example, our findings may not generalize to school populations. Future research should replicate these findings in a larger, normative sample.

Second, at present a comprehensive standardized and norm-referenced reading test (i.e., one that includes separate reading fluency, word reading, decoding, and reading comprehension subtests) is not available, making a cross-battery approach necessary in this study. Therefore, it could be argued that our results are due to differences in the characteristics of the test used (i.e., the WRMT-R and the GORT-3). However, our results regarding the sensitivity of reading fluency as compared to word reading assessments in detecting reading problems are consistent with that of previous research which utilized a variety of reading fluency measures including criterion-referenced (McCabe et al., 2001), curriculum-based (Sofie and Riccio, 2002), and norm-referenced measures (Breen and Drecktrah, 1990). Therefore, it seems unlikely that the difference in the reading fluency and word reading skills of children identified as having a specific deficit in reading fluency (*M*=20.5 standard scores points) is attributable to our choice of measures. Nevertheless, future investigation should incorporate multiple measures of reading fluency to specifically address this concern.

Lastly, these results need to be replicated and expanded upon to better understand the role of reading fluency in identifying children with reading disabilities. In addition to exploring the participant's age, other potentially important variables should be explored in a larger clinical sample. Working memory, or the ability to manipulate and hold information in short term memory, may be an important factor for reading fluency (Perfetti, 1985). Additionally, rapid naming speed may be a part of a general slow speed of processing. Speed of processing should be investigated as a potential rate-limiting factor.

In sum, reading fluency is an essential for children's academic success, as dysfluent reading is likely to adversely affect reading comprehension and thereby hamper the learning content area knowledge. Reading fluency is a key area of assessment when children are experiencing reading difficulties, as failure to do so may result in the under-identification of children with learning disabilities.

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington: American Psychiatric Association.

Anderson, R. C., Wilson, P. T., & Fielding, L. G. (1988). Growth in reading and how children spend their time outside of school. *Reading Research Quarterly, 23*, 285–303.

August, G. J., & Garfinkel, B. D. (1990). Comorbidity of ADHD and reading disability among clinic-referred children. *Journal of Abnormal Child Psychology, 18*, 29–45.

Bowers, P. G. (1993). Text reading and rereading: Determinants of fluency beyond word recognition. *Journal of Reading Behavior, 25*, 133–153.

Breen, M. J., & Drecktrah, M. (1990). Similarity among common measures of academic achievement: Implications for assessing disabled children. *Psychological Reports, 67*, 379–383.

Breznitz, Z., & Berman, L. (2003). The underlying factors of word reading rate. *Educational Psychology Review, 15*, 247–265.

Chall, J. S. (1996). *Stages of reading development* (2nd ed.). Fort Worth: Harcourt-Brace.

Chall, J. S., Jacobs, V., & Baldwin, L. (1990). *The reading crisis*. Cambridge: Harvard University Press.

Deno, S. L. (2003). Developments in curriculum-based measurement. *Remedial and Special Education, 37*, 184–192.

Dombrowski, S. C., Kamphaus, R. W., & Reynolds, C. R. (2004). After the demise of the discrepancy: Proposed learning disabilities diagnostic criteria. *Professional Psychology, Research and Practice, 35*, 364–372.

Fletcher, J. M. (1985). External validation of learning disability subtype. In B. P. Rourke (Ed.), *Neuropsychology essentials of subtype analysis* (pp. 187–211). New York: Guilford.

Fletcher, J. M., Shaywitz, S. E., Shankweiler, D. P., Katz, L., Liberman, I. Y., Stuebing, K. K., et al. (1994). Cognitive profiles of reading disability: Comparisons of discrepancy and low achievement definitions. *Journal of Educational Psychology, 86*, 6–23.

Fuchs, L. S., Fuchs, D., Hosp, M. K., & Jenkins, J. R. (2001). Text fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. *Scientific Studies of Reading, 5*(3), 239–256.

Fuchs, L. S., Fuchs, D., & Maxwell, L. (1988). The validity of informal reading comprehension measures. *Remedial and Special Education, 9*, 20–28.

Individuals With Disabilities Education Improvement Act of 2004 (IDEA), Pub. L. No. 108–446, 118 Stat. 2647 (2004).

Jenkins, J. R., Fuchs, L. S., Van Der Broek, P., Epsin, C., & Deno, S. L. (2003a). Sources of individual differences in reading comprehension and reading fluency. *Journal of Educational Psychology, 95*, 719–729.

Jenkins, J. R., Fuchs, L. S., Van Der Broek, P., Epsin, C., & Deno, S. L. (2003b). Accuracy and fluency in list and context reading of skilled and RD groups: Absolute and relative performance levels. *Learning Disabilities Research and Practice, 18*, 237–245.

Katzir, T., Kim, Y. S., Wolf, M., Morris, R., & Lovett, M. (2008). The varieties of pathways to dysfluent reading: Comparing subtypes of children with dyslexia at letter, word, and connected text levels of reading. *Journal of Learning Disabilities, 41*, 47–66.

Katzir, T., Shaul, S., Breznitz, Z., & Wolf, M. (2004). The universal and the unique in dyslexia: A cross-linguistic investigation of reading and reading fluency in hebrew- and English-speaking children with reading disorders. *Reading and Writing, 17*, 739–768.

Kaufman, A. S., & Kaufman, N. L. (1985). *Kaufman test of educational achievement*. Circle Pines: American Guidance Service.

Kuhn, M. R., & Stahl, S. A. (2004). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology, 95*(1), 3–21.

LaBerge, D., & Samuels, S. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*, 293–323.

Lefly, D. L., & Pennington, B. F. (1991). Spelling errors and reading fluency in compensated adult dyslexics. *Annals of Dyslexia, 41*, 143–162.

Leinonen, S., Muller, K., Leppanen, P., Aro, M., Ahonen, T., & Lyytinen, H. (2001). Heterogeneity in adult dyslexic readers: Relating processing skills to the speed and accuracy of oral text reading. *Reading and Writing: An Interdisciplinary Journal, 14*, 265–296.

Lesile, L., & Caldwell, J. (1995). *Qualitative reading inventory—2*. New York: Longman.

Liberman, I. Y., & Shankwiler, D. (1991). Phonology and beginning reading: A tutorial. In L. Rieben & C. A. Perfetti (Eds.), *Basic research and its implications* (pp. 3–17). Rieben: Lawrence Erlbaum.

Lombardino, L. J., Riccio, C., Hynd, G. W., & Pinheiro, S. B. (1997). Linguistic deficits in children with reading disabilities. *American Journal of Speech-Language Pathology, 6*(3), 71–78.

Lovett, M. W. (1984). A developmental perspective on reading dysfunction: Accuracy and rate in the subtyping of dyslexic children. *Brain and Language, 22*, 67–91.

Lovett, M. W. (1987). A developmental approach to reading disability: Accuracy and speed criteria of normal and deficient reading skill. *Child Development, 58*, 234–260.

Lyon, G. R. (1995). Towards a definition of dyslexia. *Annals of Dyslexia, 45*, 3–27.

Lyon, G. R., & Moats, L. C. (1997). Critical conceptual and methodological considerations in reading intervention research. *Journal of Learning Disabilities, 30*, 578–588.

Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A definition of dyslexia. *Annals of Dyslexia, 53*, 1–14.

McCabe, P. P., Margolis, H., & Barenabum, E. (2001). A comparison of Woodcock–Johnson psycho-educational battery-revised and qualitative reading inventory—II instructional reading levels. *Reading & Writing Quarterly, 17*, 279–289.

Meisinger, E. B., Schwanenflugel, P. J., & Woo, D. (2009). *The contribution of text reading fluency to reading comprehension in the elementary grades*. Unpublished manuscript.

Meyer, M. R., & Felton, R. H. (1999). Repeated reading to enhance fluency: Old approaches and new directions. *Annals of Dyslexia, 49*, 283–306.

Morris, R. D., Stuebing, K. K., Fletcher, J. M., Shaywitz, S. E., Lyon, G. R., Shankweiler, D. P., et al. (1998). Subtypes of reading disability: Variability around a phonological core. *Journal of Educational Psychology, 90*, 347–373.

Nation, K., & Snowling, M. (1997). Assessing reading difficulties: The validity and utility of current measures of reading skill. *British Journal of Educational Psychology, 67*, 259–370.

National Reading Panel. (2000). *Report of the national reading panel*. Washington: National Reading Panel.

Perfetti, C. (1985). *Reading ability*. New York: Oxford Press.

Pikulski, J. J., & Chard, D. J. (2005). Fluency: Bridge between decoding and reading comprehension. *Reading Teacher, 58*, 510–519.

Pinnell, G. S., Pikulski, J. J., Wixon, K. K., Campbell, J. R., Gough, P. B., & Beatty, A. S. (1995). *Listening to children read aloud*. Washington: US Department of Education, National Center for Education Statistics.

Raskinski, T. V. (2001). Speed does matter in reading. *The Reading Teacher, 54*(2), 146–156.

Schwanenflugel, P. J., Meisinger, E. B., Wisenbaker, J., Kuhn, M., & Morris, R. (2006). Becoming a fluent and automatic reader: A cross-sectional study. *Reading Research Quarterly, 41*, 469–522.

Shankweiler, D., Crain, S., Katz, L., Fowler, A. E., Liberman, A. M., Brady, S. A., et al. (1995). Cognitive profiles of reading-disabled children: Comparison of language skills in phonology, morphology, and syntax. *Psychological Science, 6*, 149–156.

Shankweiler, D., Lundquist, E., Katz, L., Stuebing, K., & Fletcher, J. M. (1999). Comprehension and decoding: Patterns of association in children with reading difficulties. *Scientific Studies of Reading, 3*, 69–85.

Shaywitz, S. E. (2003). *Overcoming dyslexia: A new and completely science-based program for reading problems at any level*. New York: Alfred A. Knopf.

Shaywitz, B. A., Fletcher, J. M., Holahan, J. M., Shneider, A. E., Marchione, K. E., Stuebing, K. K., et al. (1995). Innerrelationships between reading disability and attention-deficit/hyperactivity disorder. *Child Neuropsychology, 1*, 170–186.

Shinn, M. R., Good, R. H., Knutson, N., Tilly, W. D., & Collins, V. L. (1992). Curriculum-based measurement of oral reading fluency: A confirmatory analysis of its relation to reading. *School Psychology Review, 21*, 459–479.

Siegel, L. (1999). Issues in the definition and diagnosis of learning disabilities: A perspective on Guckenberger v. Boston University. *Journal of Learning Disabilities, 32*, 304–319.

Sofie, C. A., & Riccio, C. A. (2002). A comparison of multiple methods for the identification of children with reading disabilities. *Journal of Learning Disabilities, 35*, 234–244.

Stage, S. A., Sheppard, J., Davison, M., Davidson, M. M., & Browning, M. M. (2001). Prediction of first-graders' growth in oral reading fluency using kindergarten letter fluency. *Journal of School Psychology, 39*, 225–237.

Stanovich, K. E. (1999). The sociometrics of learning disabilities. *Journal of Learning Disabilities, 32*, 350–361.

Stanovich, K. E., & Siegel, L. S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of phonological-core variable-difference model. *Journal of Educational Psychology, 86*, 24–53.

Stecker, P. M., & Fuchs, L. S. (2000). Effecting superior achievement using curriculum based measurement: The importance of individual progress monitoring. *Learning Disabilities Research and Practice, 15*, 128–135.

Stuebing, K. K., Fletcher, J. M., LeDoux, J. M., Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2002). Validity if IQ-discrepancy classification of reading disabilities: A met-analysis. *American Educational research Journal, 39*, 469–518.

Taylor, B. M., Frye, B. J., & Maruyama, G. M. (1990). Time spent reading and readinggrowth. *American Educational Research Journal, 27*, 351–362.

The Psychological Corporation. (1999). *Wechsler abbreviated scale of intelligence*. San Antonio: The Psychological Corporation.

Torgesen, J. K., Rashotte, C. A., & Alexander, A. W. (2001). Principles of fluency instruction in reading: Relationships with established empirical outcomes. In M. Wolf (Ed.), *Dyslexia, fluency, & the brain*. Timonium: New York Press.

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disability (dyslexia): What have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, 45*, 2–40.

Vellutino, F. R., Scanlon, D. M., & Lyon, R. G. (2000). Differentiating between difficult-to-remediate and readily remediated poor readers. *Journal of Learning Disabilities, 33*, 223–238.

Vellutino, F. R., Scanlon, D. M., Sipay, E. R., Small, S. G., Pratt, A., Chen, R., et al. (1996). Cognitive profile of difficult-to-remediate and readily remediated poor readers: Early interventions as a vehicle for distinguishing between cognitive and experiential deficits as basic causes of specific reading disabilities. *Journal of Educational Psychology, 88*, 601–638.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive test of phonological processing*. Austin: Pro-Ed.

Wayman, M. M., Wallace, T., Wiley, H. I., Tichdt, R., & Espin, C. A. (2007). Literature synthesis on curriculum-based measurement in reading. *The Journal of Special Education, 41*(2), 85–120.

Wiederholt, J. L., & Bryant, B. R. (1986). *Gray oral reading tests—revised (GORT-R)*. Austin: Pro-ed.

Wiederholt, J. L., & Bryant, B. R. (1995). *Gray oral reading tests—third edition (GORT-3)*. Austin: Pro-ed.

Wiederholt, J. L., & Bryant, B. R. (2001). *Gray oral reading tests—fourth edition (GORT-4)*. Austin: Pro-ed.

Wolf, M., & Bowers, P. (1999). The "Double-Deficit Hypothesis" for the developmental dyslexic. *Journal of Educational Psychology, 91*, 1–24.

Wolf, M., Bowers, P., & Biddle, K. (2000). Naming-speed processes, timing, and reading: A conceptual review. *Journal of Learning Disabilities, 33*, 387–407.

Wolf, M., & Katzir-Cohen, T. (2001). Reading fluency and its intervention. *Scientific Studies of Reading, 5*, 211–229.

Wolf, M., O'Rourke, A., Gidney, C., Lovett, M., Cirino, P., & Morris, R. (2002). The second deficit: An investigation of the independence of phonological and naming-speed deficits in developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal, 15*, 43–72.

Woodcock, R. W. (1998a). *Woodcock reading mastery tests–revised*. Circle Pines: American Guidance Service.

Woodcock, R. W. (1998b). *Woodcock reading mastery test—revised*. Circle Pines: AGS.

Woodcock, R. W., & Mather, N. (1990). *Woodcock–Johnson psycho-educational battery-revised, tests of achievement*. Chicago: Riverside.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock–Johnson III test of achievement*. Itasca: Riverside.

Young, A. R., & Bowers, P. G. (1995). Individual differences and text difficulty determinants of reading fluency and expressiveness. *Journal of Experimental Child Psychology, 60*, 428–454.