Research in Developmental Disabilities 31 (2010) 1170–1175

Contents lists available at ScienceDirect

Research in Developmental Disabilities

The relationship between phonological processing skills and word and nonword identification performance in children with mild intellectual disabilities

Justin C. Wise [a], Rose A. Sevcik [a,*], MaryAnn Romski [b], Robin D. Morris [a]

[a] Department of Psychology, P.O. Box 5010, Georgia State University, Atlanta, GA 30302, United States
[b] Department of Communication, P.O. Box 4000, Georgia State University, Atlanta, GA 30302, United States

ARTICLE INFO

Article history:
Received 20 July 2010
Received in revised form 10 August 2010
Accepted 12 August 2010

Keywords:
Mild intellectual disabilities
Phonological skills
Word and nonword identification

ABSTRACT

Word and nonword identification skills were examined in a sample of 80 elementary school age students with mild intellectual disabilities and mixed etiologies who were described as struggling to learn to read by their teachers. Performance on measures of receptive and expressive vocabulary, measures of phonological awareness, and measures of word and nonword identification were included for analyses. Hierarchical regression analyses indicated that, after controlling for chronological age and vocabulary knowledge, phonological processing accounted for a large and significant amount of unique variance of both word and nonword identification. In addition, the pattern of results found in this study is similar to that obtained with typically developing learners. As with typically developing children, measures of phonological awareness were significantly correlated with measures of both reading achievement and vocabulary knowledge.

1. Introduction

Limited research exists concerning the literacy skills of children with intellectual disabilities. Recent research conducted with this population suggests that phonological awareness is related to reading performance by these individuals and that they can benefit from phonemic literacy instruction. The limited corpus of research documenting the literacy skills of children with intellectual disabilities mainly has been conducted with very small samples of children with Down syndrome. Data reported here are part of a larger ongoing project with children who have mild intellectual disabilities resulting from various etiological factors that examines the impact of two reading programs on both early developing reading skills (e.g., phonological awareness, word decoding) and the development of fluency and comprehension skills.

1.1. The relationship between phonological awareness and reading performance by children with intellectual disabilities

Children with a range of intellectual disabilities have been taught to read primarily through sight words since it has been assumed that individuals with intellectual difficulties cannot benefit from phonemic instruction because of their limited cognitive skills and associated language difficulties (e.g., Browder & Xin, 1998). Evidence for this assumption comes from an early study by Cossu, Rossini, and Marshall (1993). They reported that 10 children with Down syndrome, whose mean age

* Corresponding author. Tel.: +1 404 413 6296; fax: +1 404 413 6218.
E-mail addresses: psyjcwx@langate.gsu.edu (J.C. Wise), rsevcik@gsu.edu (R.A. Sevcik), mromski@gsu.edu (M. Romski), robinmorris@gsu.edu (R.D. Morris).

0891-4222/$ – see front matter
doi:10.1016/j.ridd.2010.08.004

was 11.4 years, were able to learn to read single Italian words yet performed poorly on measures of phonological awareness. These children evinced word and nonword reading skills that were comparable to a younger (mean age = 7.3) sample of 10 typically developing children. In contrast, the children with Down syndrome performed significantly worse than the group of typically developing children on tasks of phoneme segmentation, phoneme deletion, oral spelling, and phoneme blending. These findings prompted the authors to conclude that phonological awareness was not a prerequisite for learning to read with children with Down syndrome. One of the many criticisms of this interpretation is that the phonological awareness tasks used by Cossu and colleagues were beyond the working memory and attentional capacities of the children participating in their study. In contrast to the findings of Cossu et al., more recent research (e.g., Gombert, 2002; Snowling, Hulme, & Mercer, 2002; Verucci, Mehghini, & Vicari, 2006) has found a relationship between phonological awareness and reading performance by children with Down syndrome.

Gombert (2002) studied 11 French children with Down syndrome (mean age = 13.9) who were matched on reading ability with 11 typically developing children (mean age = 7.1). While the children with Down syndrome evinced phoneme spelling, phoneme counting, and phoneme deletion scores that were significantly lower than the group of typically developing children, a composite score of these measures of phonological awareness correlated significantly with word reading performance for both groups of children. In contrast to the Cossu et al. (1993) study, results from Gombert's study suggested that phonological awareness is involved in the process of learning to read for children with Down syndrome. Additionally, although the children with Down syndrome evinced rime judgment, rime oddity, and phoneme synthesis scores that were lower than those of the matched typically developing children, this difference was not significant. Further, scores on these phonological awareness tasks for the children with Down syndrome were considerably higher than the scores obtained on measures of phoneme spelling, phoneme counting, and phoneme deletion. This pattern of results was not seen in the group of typically developing children and supports the argument that task complexity can partially explain the group differences demonstrated in both the Cossu et al. (1993) and Gombert (2002) studies.

Similarly, Snowling et al. (2002) reported that measures of phonological awareness (e.g., syllable segmentation and phoneme identification) were correlated significantly with a measure of single word reading in a sample of 29 children with Down syndrome. Further, they also found that these children (mean age = 13.2) achieved scores on these measures that did not differ significantly from scores produced by a group of younger, typically developing children (mean age = 5.3) matched on word reading level. Just as Gombert (2002) had reported, results from this study evidenced a relationship between phonological awareness and reading in children with Down syndrome.

Snowling and her colleagues also found that the group of children with Down syndrome evinced significantly lower rhyme detection scores than the group of typically developing children. Further, in contrast to the typically developing participants, performance on the rhyme detection task did not correlate significantly with the word reading performance of the children with Down syndrome. These results led the authors to conclude that children with Down syndrome have a specific deficit in rhyming ability. They argued that the development of reading and phonological skills by the children with Down syndrome differs from the development of these skills by typically developing children since it led to only a partial development of phonological awareness skills. One potential criticism of this interpretation is that the children with Down syndrome had not received the same type of reading instruction as had the typically developing children. Differences in the pattern of the relationship between different measures of phonological awareness could be the result of instructional experiences rather than a fundamentally distinct developmental trajectory of phonological awareness.

More recently, Verucci et al. (2006) compared the phonological processing and reading skills of 17 individuals with Down syndrome (mean age = 16 .5) with a group of typically developing children (mean age = 7). Despite their older chronological age, the individuals with Down syndrome had lower mental age scores (mean age = 6.2) than the group of typically developing children (mean age = 7.6). Although the individuals with Down syndrome evinced lower performance scores on measures of phonological processing (e.g., rhyming, phoneme deletion, and syllable segmentation) and nonword reading than the typically developing children, correlation analyses indicated that scores on the phoneme deletion and rhyming tasks correlated both strongly and significantly ($p < .05$) with the accuracy of text level reading. Results of this study add further support that children with Down syndrome use phonological awareness skills for word identification and may benefit from phonics-based instruction.

1.2. Literacy instruction with children with mild intellectual disabilities

Sight word instruction has been considered a superior instructional approach for children with intellectual disabilities because of the assumption that they, due to low IQ and language difficulties, cannot benefit from phonemic instruction. In contrast to this assumption, Conners, Atwell, Rosenquist, and Sligh (2001) found that a group of children with mild intellectual disabilities with stronger decoding skills ($n = 21$) did not differ from a group of children with mild intellectual disabilities with weaker decoding skills ($n = 44$) on measures of intelligence. Further, when age was covaried out of the analysis, the groups did not differ with respect to language abilities. The only significant difference between the groups that remained was on a phonological working memory task. Decoding problems in the weaker decoding group were not due to limited intelligence or impaired language abilities. This finding led the authors to suggest that during the decoding process, those children with superior working memory skills can hold the beginning sounds of words longer while they attend to subsequent letter/sound combinations. This ability, they argued, then results in better performance in the sounding out of words. Without knowledge of the children's instructional histories, however, it is also possible that children with better early reading instruction evidence better phonological working memory skills because they have more well-defined phonological representations in their lexical store and can free up processing capacity during phonological working memory tasks.

Using direct instruction, Cupples and Iacono (2002) demonstrated that four children between the ages of 8 and 12 with Down syndrome, who were given phonological awareness training, performed better on identifying untaught words than three children with Down syndrome who were taught using sight word instruction. Training occurred over a 6 weeks period with each child attending one 45 min intervention session each week for a total of six sessions or 270 min of instruction. Cupples and Iacono demonstrated that phonological-based instruction can be effective in teaching children with Down syndrome to generalize newly acquired phonological awareness skills to the identification of untaught words with a fairly modest amount of instructional effort and in a relatively short amount of time.

More recently, Conners, Rosenquist, Sligh, Atwell, and Kiser (2006) added to the findings of Cupples and Iacono (2002) by demonstrating that children with intellectual disabilities due to mixed etiologies were able to benefit from phonological-based reading instruction. Conners et al. recruited 40 participants between the ages of 7 and 12 with IQ scores ranging from 40 to <70. These children were matched in pairs according to age, IQ, nonword reading accuracy, phonemic awareness, and language comprehension. Participants were then randomly assigned so that one member of the matched pair received phonological-based reading instruction and the other served in a no treatment control group. Children receiving reading instruction completed 22, 10–20 min lessons, delivered 2–3 days per week spanning an 8–11 weeks period of time. The children in the control group received no specific instruction during the same period. Results indicated that the reading instruction group performed significantly higher than the control group on measures of sounding out (i.e., identifying each sound of printed words and nonwords and then blending the sounds together) at post-intervention. As with the Cupples and Iacono (2002) study, these findings are especially important since both studies employed phonics-based reading instruction that was administered within relatively short amounts and periods of instructional time. Despite nominal instructional contact time, both studies were able to demonstrate that children with intellectual disabilities can benefit from phonics-based reading instruction.

2. Study purpose

The purpose of this study was to examine the relationships between phonological processing skills and word and nonword identification performance by a group of children with mild intellectual difficulties with a range of etiologies who subsequently participated in a randomized control reading intervention study. Recent research conducted with relatively small samples and primarily with children with Down syndrome has shown that phonological awareness is related to reading performance for these children and that they can benefit from phonics-based instruction. In our program of research, a multidimensional theoretical model of developmental reading processes has been used to identify critical components (decoding, fluency, and text comprehension) needed to acquire reading skills (Morris et al., in press). This approach is based on converging evidence from a range of learners that early reading incorporates two areas of linguistic skill: phonological awareness and naming retrieval/access speed (Wolf & Bowers, 1999). Data reported here are from the pre-intervention time point collected during the first 2 years of the ongoing project.

3. Methods

3.1. Participants

Eighty students classified by their home school district as having a mild intellectual disability consented to participate. The sample consisted of 56 male and 24 female students with an ethnic representation of 36 Caucasians, 36 African Americans, 6 Hispanics, 1 Asian, and 1 bi-racial student. Their mean language age in months, assessed by the Peabody Picture Vocabulary Test-III (Dunn & Dunn, 1997), was 64.33 (range = 21–119), and their mean chronological age in months was 113.15 (range = 81–144). Students were recruited across the second through fifth grades with 19 students from the 2nd grade, 21 from the 3rd grade, 17 from the 4th grade, and 23 from the 5th grade. The mean school reported IQ was 61.39 (range = 47–82). The etiology of the intellectual impairments evidenced by these students was heterogeneous and included, but was not limited to, Down syndrome, Fragile X syndrome, and unspecified. Additionally, all participants needed to be proficient in English. Exclusionary criteria included having an uncorrected visual impairment or an uncorrected hearing impairment.

3.2. Measures

Students were administered a comprehensive battery of linguistic and reading-related measures. For this study, performance on measures of receptive and expressive vocabulary, measures of phonological awareness, and measures of word and nonword identification were included for analyses.

3.2.1. Vocabulary knowledge

Receptive vocabulary knowledge was measured by the Peabody Picture Vocabulary Test-III (PPVT-III; Dunn & Dunn, 1997). The PPVT-III is a standardized measure of receptive language skills. Each easel page of the PPVT-III contains four numbered pictures. Participants were asked to choose the picture that best depicts a word spoken by the test administrator. The test manual reports internal consistency coefficients that range from .89 to .97 (median = .94) for Form A and from .86 to .96 (median = .94) for Form B. Test–retest coefficients range from .91 to .94 (median = .92).

Expressive vocabulary knowledge was measured by the Expressive vocabulary test (EVT; Williams, 1997). The EVT is composed of two broad sections. The first section asked the participant to label an item when the test administrator points to a picture or part of the body and asks a question. In the second section, a picture and stimulus words are presented and the participant is asked to respond with a one-word answer that is a synonym. Internal consistency coefficients range from .90 to .98, with a median of .95. Test–retest reliabilities are reported to range from .77 to .90 with a median score of .85.

3.2.2. Phonological processing

Phonological processing was measured with two tasks: Sound Symbol Identification and the Comprehensive Test of Phonological Processing. Sound Symbol Identification (SSI; Lovett et al., 1994) is composed of four subtests; Letter Sound Identification, Sound Combination Identification, Onset Identification, and Rime Identification. All four subtests present the child with letters or letter combinations one at a time on small cards similar to playing cards. The child's task is to say the sound represented by the letter or letter combinations. The Letter Sound Identification task is composed of individual letters while the Sound Combinations task is composed of frequent English orthographic patterns (e.g., *er*, *oy*, and *oa*). The Onset Identification task presents pairs of orthographic patterns that frequently appear together at the beginning of English words (e.g., *cl*, *sm*, and *pl*). The final subtest, the Rime Identification task, is composed of orthographic patterns often found at the end of English words (e.g., *ish*, *ent*, and *ade*).

Comprehensive Test of Phonological Processing (CTOPP; Torgeson & Wagner, 1999). The Blending and Elision subtests of the CTOPP were used to measure phonological awareness. The Blending subtest presents words in serial syllabic and phonological segments. The goal of the subtest is to combine the smaller parts to identify the whole word (e.g., "What word do these sounds make? /m//a//d/"). The Elision subtest is a phoneme deletion task that requires a child to omit a phoneme in a spoken word and then respond by saying what the new word would be (i.e., say "tiger" without saying "/g/").

3.2.3. Word and nonword identification

Word and nonword identification were measured by the Woodcock Reading Mastery Test-Revised (WRMT-R; Woodcock, 1987). Two subtests of the WRMT-R were administered: the word identification (WID) and word attack (WA) subtests. The WID subtest is a measure of single word identification skills. The WA subtest is a measure of single nonword identification skills. Internal consistency reliability coefficients of the WRMT-R obtained by split-half reliability for first grade through third grade ranged from .91 to .98 (M = .94; Woodcock, 1987).

3.3. Procedure

The research team partnered with a number of elementary schools in the Atlanta, Georgia area. After receiving permission from the school district, schools serving a large number of students classified as having a mild intellectual disability were targeted for recruitment. Principals in these schools were contacted and were offered the opportunity to participate. Teachers were asked to identify students who were non-readers. Packets contained a description of the study, a consent form, and a demographic survey which was sent home with the student. Students who returned a signed consent form were administered a battery assessing language and reading skills. All students were assessed by doctoral students or psychologists trained to administer the assessments within the students' home school during a typical school day. For the purpose of the current study, only the pre-intervention time point data were analyzed and discussed.

4. Results

Pre-intervention scores for the measures are reported in Table 1. For all analyses, raw scores were used to avoid floor effects and to increase variability among scores. A composite score for the SSI was created by averaging the performance across the four subtests that comprise the SSI and was used in all analyses. A composite score was created in order to provide

Table 1
Students' performance on measures of PA skills, knowledge of grapheme/phoneme correspondences, and semantic knowledge.

Measure	Mean	SD	Range
Blending (20 maximum score)	4.37	2.98	0–11
Elision (maximum score)	1.84	2.15	0–7
SSI composite score (26.75 maximum score)[a]	8.35	5.55	0–22
PPVT-III (204 maximum score)	70.20	23.37	13–127
EVT (190 maximum score)	47.98	10.61	23–74
WRMT-R word ID (106 maximum score)	19.19	17.74	0–62
WRMT-R word attack (45 maximum score)	3.38	5.37	0–21

PPVT-III, Peabody Picture Vocabulary Test; EVT, Expressive Vocabulary Test; WRMT-R, Woodcock Reading Mastery Test-Revised.
[a] The SSI composite score is the average score of the four subtests that comprise the SSI.

Table 2
Partial correlations among the measures vocabulary knowledge, phonological processing, and reading performance controlling for IQ.

	1.	2.	3.	4.	5.	6.	7.
1. Blending	–						
2. Elision	.43**	–					
3. SSI composite	.52**	.43***	–				
4. PPVT	.24*	.34**	.31**	–			
5. EVT	.17	.39***	.48***	.65***	–		
6. WRMT word ID	.44***	.34**	.81***	.35**	.48***	–	
7. WRMT word attack	.31**	.35**	.74***	.28*	.46***	**.65******	–

The SSI composite score is the average score of the four subtests that comprise the SSI. PPVT-III, Peabody Picture Vocabulary Test; EVT, Expressive Vocabulary Test; WRMT-R, Woodcock Reading Mastery Test-Revised.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 3
Hierarchical regression analyses predicting word and nonword identification with phonological processing skills controlling for vocabulary knowledge and IQ.

Step and predictor	Dependent variable	F_{change}	r^2_{change}	p-Value
1. PPVT-III, EVT, age	WRMT word attack	21.26	.46	<.001
2. Blending, Elision, SSI composite		32.89	.31	<.001
1. PPVT-III, EVT, age	WRMT word ID	13.66	.36	<.001
2. Blending, Elision, SSI composite		18.88	.29	<.001

The SSI composite score is the average score of the four subtests that comprise the SSI. PPVT-III, Peabody Picture Vocabulary Test; EVT, Expressive Vocabulary Test; WRMT-R, Woodcock Reading Mastery Test-Revised.

a more reliable representation of the participants' knowledge of letter-sound correspondences. Additionally, using this composite score in the regression analyses resulted in an increase in statistical power compared to the use of the four separate subtests.

4.1. Partial correlation analyses

In order to examine the strength of the relationships between vocabulary knowledge, phonological processing, and word and nonword identification skills, partial correlation analyses were conducted controlling for chronological age (see Table 2). Because standard scores were not used in the analyses, age was partialled out of the correlation analyses. While IQ has been shown not to influence the strength of decoding skills (e.g., Conners et al., 2001), age has, and is presumed to do so through instructional and real world experience.

Phonological processing correlated significantly ($p < .05$) with measures of receptive vocabulary (Blending $r = .24$, Elision $r = .34$, and SSI $r = .31$) and expressive vocabulary (Elision $r = .48$ and SSI $r = .65$). Only blending skills were not found to correlate significantly with expressive vocabulary skills. Analyses also indicated that measures of phonological processing correlated significantly ($p < .01$) with measures of word (Blending $r = .44$, Elision $r = .34$, and SSI $r = .81$) and nonword (Blending $r = .43$, Elision $r = .39$, and SSI $r = .74$) identification. Both receptive and expressive vocabulary knowledge were found to correlate moderately and significantly ($p < .01$) with word identification (receptive $r = .35$ and expressive $r = .48$) and nonword identification performance (receptive $r = .34$ and expressive $r = .41$).

4.2. Hierarchical regression analyses

Hierarchical regression analyses were conducted to determine how much unique variance phonological processing accounted for after controlling for chronological age and vocabulary knowledge. Two sets of hierarchical regression analyses were conducted; one set utilized word identification skills as the dependent variable while the second set used nonword identification skills as the dependent variable (see Table 3). For both regression analyses, chronological age and vocabulary knowledge were entered in the first step of the regression equation. In the second step of the regression equation, the two measures of phonological processing were entered.

Analyses indicated that after controlling for chronological age and vocabulary knowledge, phonological processing accounted for a large and significant amount of unique variance of both word (31%), $F_{change}(3,71) = 32.89$, $p < .001$, and nonword (29%), $F_{change}(3,71) = 18.88$, $p < .001$, identification.

5. Discussion

These results add support to previous research indicating that phonological processing skills are significantly correlated with reading performance in children with intellectual disabilities (e.g., Gombert, 2002; Snowling et al., 2002; Verucci et al., 2006). Results from this study also add to the limited corpus of research conducted with children with intellectual disabilities resulting from various etiologies and indicate that the relationships evidenced between phonological awareness and reading achievement by children with Down syndrome also are evidenced in this more heterogeneous population of intellectual disabilities.

Hierarchical regression analyses indicated that this group of children relied heavily on phonological processing skills for the purpose of word and nonword identification. After controlling for vocabulary knowledge and age, phonological processing skills accounted for 31% of unique variance in word identification performance and 29% of unique variance in nonword identification performance. These results support those of Conners et al. (2006) and suggest that children with mild intellectual disabilities rely substantially on phonological processing skills for word and nonword identification. In addition, the pattern of results found in this study is similar to that obtained with typically developing learners. As with typically developing children, measures of phonological awareness were significantly correlated with measures of both reading achievement and vocabulary knowledge. Children with mild intellectual disabilities may be able to learn to read in a manner that is similar to typically developing children.

A limitation of this study was that the children who participated were classified as having a mild intellectual disability by the school district and an independent evaluation of their intellectual abilities was not conducted. In addition, a range of IQ measures were employed, even within the same school district. Some of the school reported IQ scores in this sample also fell outside the IQ range that typically defines mild intellectual disabilities though the students themselves were classified with mild intellectual disabilities, and were served within the educational programs for them. While these factors may increase the heterogeneity of IQ scores of the sample and result in a small number of students being misclassified, it does not deter from the findings that a strong relationship between phonological processing and word level reading was evidenced. Further, all analyses reported here controlled for the effects of IQ. It would be of interest, however, for future studies to include both consistent measures as well as independent intellectual assessments in order to assess the validity of school classifications of mild intellectual disabilities.

Examining a relatively large, heterogeneous sample of children with MID, a strong relationship between phonological processing and word level reading was found. Results from the current study challenge the assumption that children with intellectual disabilities cannot benefit from phonics-based instruction and should be taught to read primarily through sight word instruction. While sight word instruction has been shown to be effective in helping individuals with intellectual disabilities identify words they interact with frequently on a daily basis, sight word instruction results in little generalization to other settings (Burns, 2007). Implications of this study are that children with mild intellectual disabilities rely on the same skills as typically developing children for word identification and that children with mild intellectual disabilities potentially can learn to read in ways similar to that of typically developing children, i.e., through phonological decoding.

Acknowledgements

This research is supported by US Department of Education Award H324K040007 to Rose A. Sevcik. This article does not necessarily reflect the positions or policies of this funding agency and no official endorsement of its content should be inferred. We thank the participants and their families, along with their schools, for their cooperation and support.

References

Browder, D., & Xin, Y. P. (1998). A meta-analysis and review of sight word research and its implications for teaching functional reading to individuals with moderate and severe disabilities. *The Journal of Special Education, 32*, 130–153.

Burns, M. K. (2007). Comparison of opportunities to respond within a drill model when rehearsing sight words with a child with mental retardation. *School Psychology Quarterly, 22*, 250–263.

Cossu, G., Rossini, F., & Marshall, J. C. (1993). When reading is acquired but phonemic awareness is not: A study of literacy in Down's syndrome. *Cognition, 46*, 129–138.

Conners, F. A., Atwell, J. A., Rosenquist, C. J., & Sligh, A. C. (2001). Abilities underlying decoding differences in children with intellectual disability. *Journal of Intellectual Disability Research, 45*, 292–299.

Conners, F. A., Rosenquist, C. J., Sligh, A. C., Atwell, J. A., & Kiser, T. (2006). Phonological reading skills acquisition by children with mental retardation. *Research in Developmental Disabilities, 27*, 121–137.

Cupples, L., & Iacono, T. (2002). The efficacy of 'whole word' *versus* 'analytic' reading instruction for children with Down syndrome. *Reading and Writing: An Interdisciplinary Journal, 15*, 549–574.

Dunn, L. M., & Dunn, L. M. (1997). *The Peabody picture vocabulary test* (3rd ed.). Circle Pines, MN: American Guidance Service.

Gombert, J.-E. (2002). Children with Down syndrome use phonological knowledge in reading. *Reading and Writing: An Interdisciplinary Journal, 15*, 455–469.

Lovett, M. W., Borden, S. L., DeLuca, T., Lacerenza, L., Benson, N. J., & Brackstone, D. (1994). Treating the core deficits of developmental dyslexia: Evidence of transfer of learning after phonologically- and strategy-based reading programs. *Developmental Psychology, 30*(6), 805–822.

Morris, R. D., Lovett, M. W., Wolf, M., Sevcik, R. A., Steinbach, K. A., Frijters, J., et al. (in press). Multiple component remediation of developmental reading disabilities: IQ, SES, and race as factors in remedial outcome. *Journal of Learning Disabilities*.

Snowling, M. J., Hulme, C., & Mercer, R. C. (2002). A deficit in rime awareness in children with Down syndrome. *Reading and Writing: An Interdisciplinary Journal, 15*, 471–495.

Torgeson, J. K., & Wagner, R. K. (1999). *The comprehensive test of phonological processing (CTOPP)*. Austin, TX: PRO-ED Inc.

Verucci, L., Mehghini, D., & Vicari, S. (2006). Reading skills and phonological awareness acquisition in Down syndrome. *Journal of Intellectual Disability Research, 50*, 477–491.

Williams, K. (1997). *Expressive vocabulary test*. Circle Pines, MN: American Guidance Service.

Wolf, M., & Bowers, P. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91*, 415–438.

Woodcock, R. W. (1987). *Woodcock reading mastery tests-revised*. Circle Pines, MN: American Guidance Service.