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Hugh W Catts
Florida State University

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The Relationship Between Speech-Language Impairments and Reading Disabilities

Hugh W. Catts
University of Kansas, Lawrence

A group of children with speech-language impairments was identified in kindergarten and given a battery of speech-language tests and measures of phonological awareness and rapid automatized naming. Subjects were followed in first and second grades and administered tests of written word recognition and reading comprehension. The children with speech-language impairments were found to perform less well on reading tests than a nonimpaired comparison group. Subjects' performance on standardized measures of language ability in kindergarten was observed to be closely related to reading outcome, especially reading comprehension. Measures of phonological awareness and rapid automatized naming, on the other hand, were found to be the best predictors of written word recognition. The implications of these findings for the early identification and remediation of reading disabilities are discussed.

KEY WORDS: reading disabilities, language impairments, phonological awareness, learning disabilities, early identification

For some time it has been observed that young children with speech-language impairments go on to demonstrate learning/reading disabilities in the early school grades. A large body of research now provides strong empirical support for these observations (see Aram & Hall, 1989; Catts, 1991a). Initially, this research combined the retrospective analysis of clinical records and the survey of academic performance to demonstrate a link between speech-language impairments and reading disabilities (Aram & Nation, 1980; Hall & Tomblin, 1978; King, Jones & Lasky, 1982). More recently, longitudinal studies have identified children with speech-language impairments in preschool or kindergarten and have observed their academic progress in the early school grades (Aram, Ekelman, & Nation, 1984; Bishop & Adams, 1990; Menyuk et al., 1991; Stark et al., 1984; Bishop & Adams, 1990; Menyuk et al., 1991; Tallal, Curtiss, & Kaplan, 1989; Wilson & Risucci, 1988). The results of this work have consistently shown that children with speech-language impairments are at risk for reading disabilities.

Although children with speech-language impairments, as a group, are at an increased risk for reading problems, research demonstrates that there is much variability in reading achievement among these children (Bishop & Adams, 1990; Tallal, Curtiss, & Kaplan, 1989). Some children with preschool speech-language impairments have been found to develop reading disabilities, whereas others have not. Recent investigations have begun to delineate some of the factors that may be related to this variability in reading outcome. For example, studies have shown that the nature of the speech-language impairment may be an important factor in predicting reading disabilities in these children. Research indicates that young children with semantic-syntactic impairments, or what is generally referred to as a language impairment, are at a higher risk for reading disabilities than are children with

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problems limited to articulation or phonology (Bishop & Adams, 1990; Hall & Tomblin, 1978; Levi, Capozzi, Fabrizi, & Sechi, 1982; Shriberg & Kwiakowski, 1988). In fact, children with articulation impairments have often been reported to have normal reading abilities (Bishop & Adams, 1990). Children with language impairments, on the other hand, are frequently found to have reading disabilities. Consistent with these findings, studies have reported significant correlations between measures of semantic-syntactic language abilities and later reading achievement. Tallal, Curtiss, and Kaplan (1989) in a longitudinal study of 67 children with speech-language impairments found a measure of receptive syntax at age 4 to be moderately correlated with reading achievement at age 8. Bishop and Adams (1990) in a longitudinal investigation of 83 children with speech-language impairments reported that MLU at 4½ and 5½ years of age was a good predictor of reading achievement at age 8. Their results also indicated that a measure of receptive syntactic abilities contributed significantly to predicting reading achievement.

In another recent investigation, Magnusson and Naucler (1990) found that measures of syntactic production and language comprehension administered to children with speech-language impairments prior to school entry were related to reading achievement in first grade. The best predictors of reading achievement, however, were not standardized language measures but rather nonstandardized measures of metalinguistic ability, specifically phonological awareness. The abilities to make rhyme judgments and to identify phonemes in words were found to be closely related to reading outcome in their subjects with speech-language impairments. Similar results have also been obtained by Menyuk et al. (1991) in a study of 130 children at risk for reading disabilities. They found standardized measures of semantic-syntactic language abilities to be significantly correlated with later reading scores. Overall, however, measures of metalinguistic abilities including phonological awareness were reported to be the best predictors of reading achievement.

The present investigation was undertaken to further examine the relationship between speech-language impairments and reading disabilities. A group of children with speech-language impairments was identified in kindergarten and administered a battery of standardized speech-language tests and nonstandardized language measures, including measures of phonological awareness. Subjects were followed in first and second grades and were given tests of reading achievement, including measures of written word recognition and reading comprehension. It was predicted that the standardized and nonstandardized language measures administered in kindergarten would be related to first and second grade reading achievement. Furthermore, research in reading and reading development suggested that the relationship between language measures and reading achievement might vary depending on how reading was assessed. Specifically, it was predicted that when reading achievement was assessed in terms of word recognition, measures such as phonological awareness would be most closely related to reading outcome. A large body of research has consistently indicated a strong relationship between early word recognition and phonological awareness (Bradley & Bryant, 1985; Fox & Routh, 1983; Liberman & Shankweiler, 1985; Lundberg, Olofsson, & Wall, 1980; Stanovich, Cunningham, & Cramer, 1984; Tunmer & Nesdale, 1985; Vellutino & Scanlon, 1987; Yopp, 1988). On the other hand, when reading achievement was measured in terms of comprehension, it was expected that standardized measures of semantic-syntactic language abilities would be particularly important in predicting reading outcome. Research indicates that such language abilities are essential to deriving an understanding of printed sentences and texts (Perfetti, 1985; Rayner & Pollatsek, 1989).

Method

Subjects

Fifty-six children with speech-language impairments (S-LI) and 30 children with normal speech-language abilities participated in this investigation. In the S-LI group, there were 40 males and 16 females. At the beginning of the study, subjects in the S-LI group were in kindergarten and were an average age of 6 years, 2 months old. Each of the subjects in this group had been referred for a speech-language evaluation in one of two Midwest public school districts. In addition to the evaluation the children in this group received in the schools, a battery of standardized speech-language tests was administered for this investigation. This battery included three measures of receptive language abilities: Peabody Picture Vocabulary Test–Revised (Dunn & Dunn, 1981), Token Test for Children (DiSimoni, 1978), Grammatical Understanding subtest of the Test of Language Development–2 (Newcomer & Hammill, 1988), and three measures of expressive language abilities: Expressive One-Word Picture Vocabulary Test (Gardner, 1979), Structured Photographic Expressive Language Test–II (Werner & Kresheck, 1983), combined performance on the Sentence Imitation and Grammatical Closure subtests of the Test of Language Development-2, and a measure of articulation: Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1986). In addition, the Block Design and Picture Completion subtests of the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1967) were administered.[1]

Children in the S-LI group had a variety of speech and language difficulties. The standardized test battery indicated that the majority of the subjects (n = 41) demonstrated a language impairment. A language impairment was operationally defined as performance of at least one *SD* below the mean on at least two of three receptive language measures and/or two of three expressive language measures. Nineteen subjects displayed impairments on both receptive and expressive language tests, 12 subjects showed language difficulties primarily on receptive measures, and 10 subjects displayed impairments primarily on expressive language tests. In some analyses for the present study, the above

[1]For children older than 6½ years, the Block Design and Picture Completion subtests from the Wechsler Intelligence Scale for Children–Revised (Wechsler, 1974) were administered. Testing was limited to the Block Design and Picture Completion subtests because of the time constraints and testing concerns imposed by the school systems. Previous researchers have also relied on the use of these subtests as a measure of nonverbal abilities (Bishop & Adams, 1990).

TABLE 1. Mean standard scores (and standard deviations) on standardized tests in kindergarten for the normal and speech-language impaired (S-LI) groups and the language-impaired (LI) and articulation-impaired (AI) subgroups within the S-LI group.

	Normal $N = 30$	S-LI $N = 56$	LI $n = 41$	AI $n = 15$
PPVT	108.3 (7.5)	90.8 (14.6)	85.0 (10.8)	106.9 (11.2)
Token	499.0 (3.8)	494.0 (4.0)	493.3 (2.8)	498.7 (2.9)
TOLD-2	104.3 (10.9)	87.5 (14.2)	81.7 (10.5)	103.1 (10.9)
EOWPVT	113.4 (11.5)	97.7 (13.8)	92.3 (9.0)	112.7 (13.9)
SPELT-II	108.5 (13.1)	84.9 (17.8)	78.2 (11.7)	103.1 (19.4)
Picture completion	12.9 (1.8)	11.5 (2.4)	10.8 (2.2)	13.3 (2.2)
Block design	12.4 (1.6)	10.2 (2.4)	9.4 (2.0)	12.3 (2.3)

Note. PPVT = Peabody Picture Vocabulary Test-Revised; Token = Token Test for Children; TOLD-2 = Test of Language Development-2, Syntax Quotient; EOWPVT = Expressive One-Word Picture Vocabulary Test; SPELT-II = Structured Photographic Expressive Language Test-II.

children with language impairments are referred to as the LI subgroup. The remaining 15 subjects in the S-LI group did not meet the criteria for a language impairment but demonstrated articulation problems and/or were enrolled in articulation therapy during the kindergarten school year (referred to as the AI subgroup). Twelve of these subjects performed below average on the Goldman-Fristoe Test of Articulation (mean percentile = 16.9%, range < 1–33%). The other three subjects had been enrolled in articulation therapy throughout the kindergarten year and had resolved their articulation difficulties by the time of our assessment. Nevertheless, enrollment in articulation therapy was considered sufficient criterion for inclusion in this investigation. Some of the subjects in the LI subgroup (37%) also had articulation impairments. However, these subjects were included with the other subjects demonstrating language impairments (i.e., LI subgroup) when examining differences between subgroups. All subjects in the S-LI group demonstrated nonverbal abilities within the normal range. School records also indicated that children in this group had hearing and corrected vision within normal limits and no history of emotional disorders.

Thirty children without a history of speech-language impairments or a referral for such impairments also participated in this study. These children served as a comparison group to evaluate the performance of the S-LI group on measures of reading achievement. The normally developing subjects were enrolled in the same classrooms or schools as subjects in the S-LI group and were approximately the same age (6 years, 1 month at the beginning of the study). There were 18 males and 12 females in this group. Each of these children performed within normal limits on the battery of speech-language tests and measures of nonverbal ability.

The means and standard deviations for the normal and S-LI groups on the speech-language and nonverbal tests are presented in Table 1. Also shown in Table 1 are the means and standard deviations for the LI and AI subgroups within the S-LI group.

Procedures and Materials

The subjects were initially evaluated in the spring of their kindergarten school year. At that time, each subject was administered the standardized tests of receptive language, expressive language, articulation, and nonverbal abilities described above. In addition, subjects were given a set of nonstandardized language tasks, which included two measures of phonological awareness and three measures of rapid automatized naming. As noted earlier, phonological awareness has been shown to be related to early reading achievement, especially word recognition. Rapid automatized naming has also been linked with written word recognition (Denckla & Rudel, 1976; Wagner & Torgesen, 1987; Wolf, 1984).

Phonological Awareness. Two tasks were used to assess subjects' phonological awareness. The deletion task, which was adapted from Rosner (1971), required the subject to delete the initial syllable or phoneme from a word and say the remaining sound sequence. Subjects were introduced to the task by the use of three picture plates. The first plate displayed a picture of a cow and a boy. Subjects were instructed to say "cowboy." The investigator then covered the picture of the cow and said, "Now, say cowboy without the cow." The same procedures were used with picture plates displaying a cup and a cake and a tooth and a brush. Following these training trials, 20 stimulus items were administered, without the use of picture plates to assist the subjects. Test items progressed from syllable deletion of compound words (e.g., *base*ball, *rail*road) and two-syllable words (e.g., *ba*by, *per*son) to phoneme deletion in monosyllabic words (e.g., *s*it, *t*all). In all cases, the sound sequence remaining after segment deletion was a high-frequency word (e.g., sit–it). Corrective feedback was given for the first five errors and testing was stopped after eight consecutive incorrect responses.

The blending task required the subject to blend together and pronounce syllables or phonemes. A hand puppet was used during training and stimulus presentation. Subjects were told that the puppet did not speak correctly, but rather "said words one sound at a time." Subjects were instructed to listen carefully and to say the word "the right way." The investigator illustrated the correct response to the puppet's pronunciation of *rein deer*. This was followed by the practice items *bed room, suit case,* and *snow man*. Twenty-one test items followed. These progressed from the blending of words/syllables (e.g., *birth day, mo ther*) to onset and rimes (e.g., *f un, s ing*) and finally to phonemes (e.g., *f ish, s oa p*). Corrective feedback was provided for the practice items and the first five errors. All test items were administered.

The deletion and blending tasks were chosen over numerous other phonological awareness tasks because they measured awareness of both syllables and phonemes. Tasks that assess only phoneme awareness often are not sensitive to individual differences among kindergarten children. The awareness of phonemes appears to be related in part to knowledge of the alphabet principle and thus does not generally emerge until after formal reading instruction has begun (Bowey & Francis, 1991; Liberman, Shankweiler, Fischer, & Carter, 1974; Morais, Cary, Alegria, & Bertelson, 1979; Read, Zhang, Nie, & Ding, 1986). The cognitive demands of the deletion and blending measures were also judged to be more appropriate for kindergarten children with S-LI than were those of other phonological awareness measures.

Rapid automatized naming. Three rapid automatized naming tasks were employed in this study. These included the rapid naming of objects task, RANOBJ, the rapid naming of colors task, RANCOL, and the rapid naming of animals task, RANAN. RANOBJ and RANCOL were similar to those used by Denckla and Rudel (1976) and Wolf (1984). In these tasks, the subjects were instructed to rapidly name a series of common objects (RANOBJ) or colors (RANCOL) displayed on 11 × 14-inch stimulus charts. Each chart contained 50 stimulus items consisting of five objects or five colors repeated randomly in five horizontal rows of 10 items each. Prior to beginning, all subjects demonstrated their ability to name each of the five objects or colors in isolation. Subjects were then instructed to name as quickly as possible each item on the chart, proceeding left to right, row by row. A stopwatch was used to measure (in 0.1 seconds) the total time necessary to name all 50 items on the chart.

A similar format was used in the rapid naming of animals task (RANAN). In this task, subjects rapidly named a series of colored animals presented on an 8 × 11-inch chart. There were a total of 24 stimulus items consisting of three animals (cow, pig, horse) randomly displayed in one of three colors (black, blue, red) and randomly repeated in four rows of six items each. Subjects were required to rapidly provide the color and name of each of the items (e.g., red pig, blue cow) on the stimulus chart. The total duration to name all 24 items was measured.

As noted above, rapid automatized naming tasks were selected because of their documented relationship to reading ability. Rapid automatized naming has generally been shown to be among the best predictors of word recognition in young children (Blachman, 1984; Felton & Brown, 1990; Wolf, Bally, & Morris, 1986).

Reading achievement. Reading achievement was assessed in the first and second grades. The Word Identification (Word Id) and Word Attack subtests from the Woodcock Reading Mastery Tests—Revised (Woodcock, 1987) were administered to subjects in the spring of first and second grade. These subtests required subjects to read a list of words or pseudo-words presented in isolation, and as such, served as measures of written word recognition. In second grade, subjects were also given the Gray Oral Reading Test–Revised (GORT-R) (Wiederholt & Bryant, 1986). In addition to an oral reading quotient, this test provided a measure of speed and accuracy of word recognition in context and a measure of reading comprehension. The GORT-R was not administered in the first grade because the majority of the subjects with S-LI had limited reading abilities at that time.

All subjects in the S-LI and normal groups completed the reading tests during first grade. Six subjects in the S-LI group and 1 subject in the normal group moved away and were unavailable for testing in the second grade. In addition, some of the subjects with S-LI repeated their kindergarten year (n = 5), whereas others were placed in developmental first grade classes prior to going to first grade (n = 18). Developmental first (D-1) classes have been instituted in some school districts to allow young or slowly developing children (often vaguely defined) an extra year of maturation before beginning first grade and formal reading instruction. Children in D-1 programs in our school districts repeated kindergarten classes during half of the school day and received primarily the nonacademic curriculum (e.g., art, music) of first grade during the other half of the day. In the case of the subjects repeating kindergarten or placed in D-1 classes, standardized speech-language tests and measures of phonological awareness and rapid naming were administered during the second year of kindergarten (or D-1 classes). The results of this testing served as these subjects' kindergarten data and were subsequently used for data analysis.[2]

Results

The group means and standard deviations for reading achievement in first and second grades are displayed in

[2]Data analyses were also carried out using the data from the first-year kindergarten test battery for children who repeated kindergarten or attended D-1 classes. Data from eight repeaters or D-1 subjects, however, were not available for these analyses. These subjects were already in the second year of kindergarten or were in D-1 classes when the investigation began. Nevertheless, the results of analyses involving first-year kindergarten data for the repeaters were very similar to those reported below.

TABLE 2. Mean standard scores (and standard deviations) on tests of reading achievement for the normal and speech-language impaired (S-LI) groups and for the language-impaired (LI) and articulation-impaired (AI) subgroups within the S-LI group.

	Normal	S-LI	LI	AI
First grade	$N = 30$	$N = 56$	$n = 41$	$n = 15$
Word Id	110.4 (15.4)	96.2 (17.4)	91.8 (16.5)	108.3 (14.0)
Word Attack	99.1 (14.2)	86.8 (14.4)	83.7 (14.0)	95.5 (11.9)
Second grade	$N = 29$	$N = 50$	$n = 37$	$n = 13$
Word Id	107.6 (14.5)	91.0 (19.6)	85.6 (19.0)	106.3 (11.9)
Word Attack	97.0 (14.9)	82.2 (16.6)	77.5 (16.4)	95.5 (7.7)
Gray Oral Reading Test	97.7 (13.8)	85.1 (18.0)	77.8 (14.0)	105.8 (10.5)

Table 2. As can be observed, the S-LI group demonstrated lower reading achievement scores than the normal group in both first and second grades. Further inspection, however, reveals that these differences are primarily the result of the poor performance of the subgroup of subjects with language impairments (i.e., LI subgroup). Multivariate analysis of variance indicated significant group/subgroup differences on first grade (multivariate $F = 6.9$, $df = 4, 164$, $p < .01$) and second grade reading tests (multivariate $F = 9.6$, $df, = 6, 148$, $p < .01$). Analysis of variance and follow-up t tests showed that the LI subgroup performed significantly less well than the normal group on first grade Word Id ($t = 4.8$, $df = 69$, $p < .01$), first grade Word Attack ($t = 4.6$, $df = 69$, $p < .01$), second grade Word Id ($t = 5.2$, $df = 64$, $p < .01$), second grade Word Attack ($t = 5.0$, $df = 64$, $p < .01$), and the Oral Reading Quotient of the Gray Oral Reading Tests ($t = 5.8$, $df = 64$, $p < .01$). The subgroup of children with primarily articulation impairments (e.g., AI subgroup), on the other hand, had reading scores within the normal range and t tests indicated that they did not differ significantly from the control group on any of the reading measures ($p > .05$).

Beyond group or subgroup differences in reading achievement, the primary concern of this investigation was the relationship between kindergarten language abilities and reading achievement in children with speech-language impairments. To address this relationship, correlational and multiple regression analyses were undertaken. Because the population of interest in this study and others like it (e.g., Bishop & Adams, 1990; Magnusson & Naucler, 1990) was children with speech and language impairments, the above analyses were completed on data from the S-LI group as a whole. Such a procedure also allowed for the examination of a wide range of speech and language abilities in relationship to reading achievement. Data analyses are presented separately for first and second grade reading achievement.

First Grade

Table 3 displays the correlational coefficients between reading achievement measures in first grade and language measures in kindergarten for the S-LI group. Partial correlations are presented in order to control for possible variability introduced by subjects showing different rates of matriculation to first grade. Recall that most subjects with S-LI went directly to first grade from kindergarten. Others, however, repeated kindergarten or were placed in D-1 classrooms prior to first grade. A bivariate variable, matriculation rate (MATR), was used to control for these differences. Whereas this variable was not significantly related to first grade reading achievement, it did explain a small amount of variance in second grade reading. Also in this analysis, subjects' performances on standardized tests were partitioned into measures of receptive language (REC LANG), expressive language (EXP LANG), articulation (ARTIC), and nonverbal abilities (NONVERBAL). REC LANG and EXP LANG were calculated by converting subjects' performances on each of the standardized language tests (receptive or expressive) to z scores and averaging these scores. ARTIC represents the total number of errors on the Goldman-Fristoe Test of

TABLE 3. Pearson product-moment correlation coefficients between the kindergarten measures and first grade reading achievement tests for the subjects with speech-language impairments ($N = 56$).

	Word Id	Word Attack
REC LANG	.29*	NS
EXP LANG	.37	.49
ARTIC	NS	NS
NONVERBAL	NS	NS
DELETION	.59	.60
BLENDING	.46	.53
RAPID NAMING OF ANIMALS	.52	.42
RAPID NAMING OF OBJECTS	.53	.44
RAPID NAMING OF COLORS	.48	.35

Note. REC LANG = Overall measure of receptive language; EXP LANG = Overall measure of expressive language; ARTIC = Number of errors on the Goldman-Fristoe Test of Articulation; NONVERBAL = Estimate of nonverbal abilities. Correlation coefficients for rapid naming tasks are expressed in absolute values rather than negative correlations.

*$p < .05$, all other significant correlations $p < .01$.

Articulation and NONVERBAL is the combined performance on the Block Design and Picture Completion subtests of the WPPSI. Correlational analysis indicated no significant relationship between first grade reading achievement and articulation or between first grade reading and nonverbal abilities. Low-moderate or nonsignificant correlations were found between reading achievement and receptive and expressive language measures. Higher correlations were generally obtained for reading achievement and measures of phonological awareness and rapid automatized naming, with the deletion task showing the highest correlation with reading achievement in first grade.

To examine the relative contributions of the kindergarten measures in explaining the variance in first grade reading achievement among the subjects in the S-LI group, hierarchical multiple regression analyses were performed. Such analyses have often been used to examine the contributions of different variables in explaining reading achievement (e.g., Stanovich & West, 1989). In the present analyses, omnibus measures of phonological awareness (PA) and rapid automatized naming (RAN) were used. PA was created by converting subjects' performances on the deletion and blending tasks to *z* scores and averaging these scores. A similar procedure was used to convert the three measures of rapid automatized naming into the omnibus measure RAN. Also included in these analyses were the overall measures of expressive (EXP LANG) and receptive language (REC LANG).

A series of fixed-order, stepwise, multiple-regression analyses were performed. Again, to control for variations from differences in matriculation rate, the bivariate variable MATR was entered first in each of these analyses. Next, the variable NONVERBAL was entered to control for nonverbal intellectual abilities.[3] Following these variables, the language measures were entered in several fixed orders. In each case, the measures that were proposed to be related to comprehension, that is, REC LANG and EXP LANG, were entered into the analyses separately, but consecutively. These variables were either preceded or followed in the stepwise analyses by PA and RAN, the variables predicted to be related to word recognition (see Table 4). Results indicated that when entered before REC LANG and EXP LANG measures, the PA and RAN measures accounted for 44–45% of the variance in Word Id and 42% of the variance in Word Attack. Once the phonological awareness and rapid-naming tasks were entered into the regression analyses, REC LANG and EXP LANG accounted for no significant amount of variance in Word Id and a small amount of variance in Word Attack. When the standardized language measures REC LANG and EXP LANG were entered before PA and RAN, they accounted for a significant amount of the variance in both Word

TABLE 4. R^2 **change in fixed-order multiple-regression analyses for first grade reading achievement in subjects with speech-language impairments.**

Steps in regression	Reading achievement: Word Id	Word Attack
1. MATR	NS	NS
2. NONVERBAL	NS	NS
3. PA	.32	.37
4. RAN	.12	.05*
5. REC LANG	NS	NS
6. EXP LANG	NS	.05*
3. RAN	.29	.18
4. PA	.16	.24
5. EXP LANG	NS	NS
6. REC LANG	NS	.07
3. EXP LANG	.14	.24
4. REC LANG	NS	NS
5. PA	.17	.17
6. RAN	.12	.06*
3. REC LANG	.10*	NS
4. EXP LANG	NS	.24
5. RAN	.18	.10
6. PA	.12	.13

Note. MATR = Matriculation rate; NONVERBAL = Estimate of nonverbal abilities; PA = Overall measure of phonological awareness; RAN = Overall measure of rapid naming; REC LANG = Overall measure of receptive language; EXP LANG = Overall measure of expressive language.
*$p < .05$, all other significant correlations $p < .01$.

Id and Word Attack. A large amount of variance, however, remained and was explained in part by the phonological awareness and rapid-naming measures. PA and RAN accounted for 29–30% of the remaining variance in Word Id and 23% of the variance in Word Attack. Thus the phonological awareness and rapid-naming tasks appeared to better account for variance in first grade tests of word recognition than did standardized measures of receptive and expressive language.

Second Grade

Table 5 displays the partial correlations between kindergarten measures and second grade tests of reading achievement. In addition to the Word Id and Word Attack subtests, reading achievement scores in second grade included a measure of speed and accuracy (S/A) of word recognition and a measure of reading comprehension (C) from the Gray Oral Reading Tests–Revised (GORT-R). The correlational analysis showed that the phonological awareness and rapid-naming tasks continued to display moderate correlations with measures of reading achievement in second grade. As was generally the case in first grade, standardized measures of receptive and expressive language were less correlated with the Word Id and Word Attack subtests than were the phonological awareness and rapid automatized naming tasks. Receptive and expressive language measures, however, were found to have comparable correlations to phonological

[3]It is common practice in studies of reading development and disorders to control for intellectual ability prior to examining other potential contributing factors (Thomson, 1984). Generally both verbal and nonverbal intellectual abilities are partialed out in regression analyses. However, the standardized language measures used in this study overlap considerably with measures of verbal intelligence. Because the standardized language measures were more central to this investigation than verbal intelligence, measures of verbal IQ were not considered.

TABLE 5. Pearson product-moment correlation coefficients between kindergarten measures and second grade reading achievement tests for the subjects with speech-language impairments (N = 50).

	Word Id	Word Attack	GORT-R (S/A)	GORT-R (C)
REC LANG	.31*	.37	.52	.71
EXP LANG	.42	.46	.59	.69
ARTIC	NS	NS	NS	NS
NONVERBAL	NS	NS	NS	.33*
DELETION	.55	.63	.61	.56
BLENDING	.39	.55	.45	.50
RANAN	.51	.46	.45	.35*
RANOBJ	.54	.56	.63	.46
RANCOL	.48	.43	.53	.40

Note. GORT-R (S/A) = Speed and accuracy score from the Gray Oral Reading Test—Revised; GORT-R (C) = Comprehension score from the Gray Oral Reading Tests—Revised; REC LANG = Overall measure of receptive language; EXP LANG = Overall measure of expressive language; ARTIC = Number of errors on the Goldman-Fristoe Test of Articulation; NONVERBAL = Estimate of nonverbal abilities; RANAN = Rapid naming of animals; RANOBJ = Rapid naming of objects; RANCOL = Rapid naming of colors. Correlation coefficients for rapid naming tasks are expressed in absolute values rather than negative correlations.
*$p < .05$, all other significant correlations $p < .01$.

awareness and rapid-naming measures for the GORT-R speed and accuracy measure. In the case of the GORT-R comprehension measure, REC LANG and EXP LANG demonstrated higher correlations than the phonological awareness and rapid-naming tasks. These various relationships were borne out further in multiple-regression analyses.

A series of fixed-order multiple regression analyses was performed on the second grade reading measures. Again, MATR and NONVERBAL were entered as the first two variables. The standardized language and phonological awareness and rapid-naming measures were then entered in various orders (see Table 6). These analyses revealed a similar pattern of results to that in first grade for the reading achievement measures concerning word recognition (i.e., Word Id, Word Attack, & GORT-R Speed/Accuracy). In the regression analyses involving these measures, phonological

TABLE 6. R^2 changes in fixed-order multiple-regression analyses for second grade reading achievement in subjects with speech-language impairments.

	Reading achievement			
Steps in regression	Word Id	Word Attack	GORT-R (S/A)	GORT-R (C)
1. MATR	.16	.10	.13	.11
2. NONVERBAL	NS	NS	NS	.10
3. PA	.23	.36	.26	.25
4. RAN	.14	.10	.16	.07*
5. REC LANG	NS	NS	NS	.13
6. EXP LANG	NS	NS	NS	NS
3. RAN	.26	.24	.30	.16
4. PA	.11	.22	.13	.15
5. EXP LANG	NS	NS	NS	.09
6. REC LANG	NS	NS	NS	.06*
3. REC LANG	.08*	.10	.19	.35
4. EXP LANG	.07*	.07*	.09	.06*
5. RAN	.16	.14	.14	.04*
6. PA	.07*	.16	.04*	NS
3. EXP LANG	.15	.17	.26	.33
4. REC LANG	NS	NS	NS	.07
5. PA	.09	.20	.06*	NS
6. RAN	.13	.10	.12	NS

Note. GORT-R (S/A) = Speed and accuracy score from the Gray Oral Reading Tests—Revised; GORT-R (C) = Comprehension score from the Gray Oral Reading Tests—Revised; MATR = Matriculation rate; NONVERBAL = Estimate of nonverbal abilities; PA = Overall measure of phonological awareness; RAN = Overall measure of rapid naming; REC LANG = Overall measure of receptive language; EXP LANG = Overall measure of expressive language.
*$p < .05$, all other significant R^2 changes $p < .01$.

awareness and rapid-naming tasks proved to be better predictors than did standardized measures of language ability. PA and RAN accounted for a large proportion of the variance in Word Id (37%), Word Attack (46%), and GORT-R Speed/Accuracy (42%). Once the effects of PA and RAN had been partialed out, REC LANG and EXP LANG accounted for no significant amount of the remaining variance. If, on the other hand, the standardized language measures were entered before PA and RAN, they accounted for a significant amount of variance in word recognition measures. But again, much variance remained unexplained and was accounted for in part by the phonological awareness and rapid-naming tasks.

A different pattern of results was obtained for the measure of reading comprehension on the GORT-R. In this case, the standardized language measures proved to be better predictors. These measures accounted for a significant amount of variance in reading comprehension over and above that explained by PA and RAN. (see Table 6). PA and RAN accounted for 32% of the variance in reading comprehension when entered first. REC LANG and EXP LANG, however, accounted for an additional 15% of the variance. When entered first, EXP LANG and REC LANG explained 41% of the variance in GORT-R (C). Once the effects of the standardized language measures had been partialed out, the R^2 change for the phonological awareness measure was nonsignificant. The rapid naming tasks, however, continued to explain a small but significant amount of variance in reading comprehension.

Discussion

The present study provides further documentation of the relationship between speech-language impairments and reading disabilities. Our findings indicate that children with speech-language impairments are at an increased risk for reading disabilities. Many of the subjects in the S-LI group had begun by the early school grades to fall behind their normal-language peers in reading achievement. The difficulties of the subjects with S-LI were observed in measures of word recognition in first and second grades and a measure of reading comprehension in second grade.

Although many of the subjects with S-LI were experiencing reading problems, others were not. An examination of the individual subject data showed that approximately 50% of the subjects in the S-LI group were reading within normal limits in the first and second grades.[4] Other studies have reported similar percentages of unimpaired readers among subjects with S-LI (Aram, Ekelman, & Nation, 1984; Garvey & Gorden, 1973; Padget, 1988; Tallal et al., 1989; Wilson & Risucci, 1988). In attempting to explain the variability in reading outcome, our results indicated that certain speech-language abilities were related to reading achievement, whereas others were not. Specifically, results showed that articulation ability was unrelated to reading achievement. Correlations between articulation ability and reading achievement were low and nonsignificant both for first and second grade reading achievement. In addition, children with articulation impairments alone (i.e., AI subgroup) generally performed at or above the level of the normal group in reading achievement. These findings are consistent with other studies that have failed to observe a relationship between articulation impairments and reading disabilities (Bishop & Adams, 1990; Hall & Tomblin, 1978; King, Jones, & Lasky, 1982; Lewis & Freebairn, 1992; Levi et al., 1982).

Magnusson and Naucler (1987, 1990), on the other hand, have proposed that a subgroup of children with articulation impairments may have a high incidence of reading disabilities. They suggest that children who show sequential errors (e.g., assimilations, metathesis) are at a greater risk for reading problems than are those that have primarily segmental errors (e.g., substitutions, deletions). A post hoc error analysis in the present study failed to reveal a relationship between type of error (measured in terms of phonological processes) and reading disabilities. However, the target words from the Goldman-Fristoe Test of Articulation used in the present study do not generally lend themselves to the production of sequential errors. In fact, the stimulus items on this test were selected primarily to facilitate the assessment of segmental errors rather than intra- and intersyllabic phonological processes (e.g., metathesis). In several earlier studies, the present author also found a relationship between reading problems and specific types of phonological errors (e.g., weak syllable deletion, assimilation) in multisyllabic words and phonetically complex phrases (Catts, 1986, 1989a). Future investigations directed more specifically at the association between articulation problems and reading disabilities will be necessary to better understand this relationship.

Whereas articulation ability was found to be unrelated to reading achievement in the present study, standardized measures of receptive and expressive language abilities and measures of phonological awareness and rapid automatized naming were observed to be associated with reading outcome. However, the specific relationships of these measures to reading achievement depended on how reading was measured. When reading was assessed in terms of word recognition, both in isolation and in context, measures of phonological awareness and rapid naming proved to be the best predictors of reading outcome. Once phonological awareness and rapid automatized naming were considered in regression analyses, measures of receptive and expressive language abilities accounted for very little or no significant variance in tests of word recognition.

A large body of research involving children with no apparent history of speech-language impairments has also documented a relationship between word recognition and phonological awareness and rapid-naming abilities (Catts, 1989a; Wagner & Torgesen, 1987). This work has shown that deficits in phonological awareness and rapid automatized naming often precede and are closely associated with problems in learning to recognize printed words (e.g., Bradley & Bryant, 1985; Wolf, 1984). On the basis of this research, it has been proposed that phonological awareness and rapid-naming deficits lie near the core of reading disabilities in

[4]These subjects' combined scores on the Word Id and Word Attack subtests in first and second grades were not more than one standard deviation below the mean of those for the normal-language group.

young children (Catts, 1989b; Stanovich, 1988). The results from this study as well as those from others (Magnusson & Naucler, 1990; Menyuk et al., 1991) indicate that these same deficits may also account, at least in part, for word recognition difficulties in children with speech-language impairments. It should also be noted that although measures of phonological awareness and rapid naming accounted for some overlapping variance, these measures independently explained large amounts of variance in word recognition. This finding is consistent with other work that suggests that although phonological awareness and rapid-naming tasks both involve the use of phonological information and have been labeled phonological processing tasks, they contribute somewhat independently in explaining differences in word recognition ability (Blachman, 1984; Felton & Brown, 1990; Wagner et al., 1987).

In the present study, phonological awareness and rapid naming were also found to be related to a measure of reading comprehension given in second grade. This relationship, however, was not independent of other language abilities. It was observed that standardized measures of semantic-syntactic language abilities accounted for individual differences in reading comprehension over and above that accounted for by phonological awareness and rapid naming. Such a finding was predicted on the basis of current theories of reading comprehension (Gough & Tunmer, 1986; Perfetti, 1985; Sticht & James, 1984). Comprehension of printed text requires the ability to process the semantic-syntactic aspects of language. In fact, some have argued that these higher-level language abilities are of primary importance in learning to understand printed materials (Goodman, 1967; Smith, 1986). Others, however, have proposed that although semantic-syntactic language abilities are very important for reading comprehension, word recognition skills play an independent role in explaining variability in comprehension, especially in the early school grades (Gough & Tunmer, 1986; Hoover & Gough, 1990). This proposal has been supported by numerous studies documenting the influence of word recognition on the reading comprehension of beginning readers (e.g., Curtis, 1980; Hoover & Gough, 1990; Stanovich, Cunningham, & Feeman, 1984; Stanovich, Nathan, & Vala-Rossi, 1986; Vellutino & Scanlon, 1991).

In light of this work, the findings of the present study concerning the relationship between comprehension and phonological awareness and rapid-naming were somewhat surprising. Given the role of word recognition in reading comprehension and the observation that phonological awareness and rapid-naming tasks predicted word recognition, it was expected that these latter variables would independently account for variance in reading comprehension. However, results showed that after semantic-syntactic measures had been partialed out, rapid-naming tasks accounted for only a small amount of variance in reading comprehension, and phonological awareness measures accounted for no variance in reading comprehension. Future studies thus will need to examine further the role of various language abilities in explaining individual differences in reading comprehension among children with speech-language impairments.

Clinical Implications

The findings of the present investigation converge with those of other recent studies to indicate that children with speech-language impairments are at an increased risk for reading disabilities. As a result, these children should be considered primary candidates for early intervention programs designed to prevent or limit reading disabilities. Children with speech-language impairments are often identified in preschool or kindergarten, and thus represent a preselected clinical population. Many of these children are already receiving some form of intervention. This intervention might be expanded to include efforts to prevent or limit reading difficulties. Not all preschool children with speech-language impairments, however, are at risk for reading disabilities. Early identification procedures need to be developed to identify those children most at risk for reading problems. The present study suggests that children with semantic-syntactic language impairments and phonological awareness and rapid-naming deficits most often have reading disabilities. Standardized and reliable measures of semantic-syntactic language abilities are available and can be used for early identification purposes (e.g., DiSimoni, 1978; Newcomer & Hammill, 1988). These tests should be supplemented by standardized measures of phonological awareness (Lindamood & Lindamood, 1979; Sawyer, 1987; Torgesen & Bryant, 1993a) and research-based measures of rapid automatized naming (e.g., Wolf, Bally, & Morris, 1986).

Many early intervention programs for children with speech-language impairments target semantic-syntactic language abilities. The present study suggests that these abilities are important for reading comprehension, and thus should be targeted in intervention programs for reading disabilities. Semantic-syntactic language abilities should be promoted by activities and experiences rich in oral as well as written language. Early exposure to written language not only may facilitate language knowledge, but can illustrate the conventions and functions of print (Norris, 1989, 1991). In addition, intervention programs should be supplemented with activities to increase phonological awareness (Catts, 1991b; Catts & Vartiainen, 1993; Torgesen & Bryant, 1993b). Research indicates that phonological awareness can be facilitated and that such facilitation can improve reading outcome (Alexander et al., 1991; Ball & Blachman, 1988; Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1989; Cunningham, 1990; Lie, 1991; Lundberg, Frost, & Peterson, 1988; Williams, 1980; Yopp, 1992). Future investigations, of course, will be necessary to evaluate the effectiveness of phonological awareness and language-literacy programs for children with speech-language impairments.

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References

Alexander, A., Anderson, H., Heilman, P., Voeller, K., & Torgesen, J. (1991). Phonological awareness training and remediation of analytic decoding deficits in a group of severe dyslexics. *Annals of Dyslexia, 41,* 193–206.

Aram, D., Ekelman, B., & Nation, J. (1984). Preschoolers with language disorders: 10 years later. *Journal of Speech and Hearing Research, 27,* 232–244.

Aram, D., & Hall, N. (1989). Longitudinal follow-up of children with preschool communication disorders: Treatment implications. *School Psychology Review, 18,* 487–501.

Aram, D., & Nation, J. (1980). Preschool language disorders and subsequent language and academic difficulties. *Journal of Communication Disorders, 13,* 159–179.

Ball, E., & Blachman, B. (1988). Phoneme segmentation training: Effect on reading readiness. *Annals of Dyslexia, 38,* 208–225.

Bishop, D., & Adams, C. (1990). A prospective study of the relationship between specific language impairment, phonological disorders, and reading retardation. *Journal of Child Psychology and Psychiatry, 21,* 1027–1050.

Blachman, B. (1984). Relationship of rapid naming ability and language analysis skill to kindergarten and first-grade reading achievement. *Journal of Educational Psychology, 76,* 610–622.

Bowey, J., & Francis, J. (1991). Phonological analysis as a function of age and exposure to reading instruction. *Applied Psycholinguistics, 12,* 91–121.

Bradley, L., & Bryant, P. (1983). Categorizing sounds and learning to read: A causal connection. *Nature, 30,* 419–421.

Bradley, L., & Bryant, P. (1985). *Rhyme and reason in reading and spelling.* International Academy for Research in Learning Disabilities Monograph Series, No. 1. Ann Arbor, MI: University of Michigan Press.

Byrne, B., & Fielding-Barnsley, R. (1989). Phonemic awareness and letter knowledge in the child's acquisition of the alphabetic principle. *Journal of Educational Psychology, 82,* 429–438.

Catts, H. (1986). Speech production/phonological deficits in reading-disordered children. *Journal of Learning Disabilities, 19,* 504–508.

Catts, H. (1989a). Phonological processing deficits and reading disabilities. In A. Kamhi & H. Catts (Eds.), *Reading disabilities: A developmental language perspective.* Boston: Allyn & Bacon.

Catts, H. (1989b). Defining dyslexia as a developmental language disorder. *Annals of Dyslexia, 39,* 50–64.

Catts, H. (1991a). Early identification of reading disabilities. *Topics in Language Disorders, 12,* 1–16.

Catts, H. (1991b). Facilitating phonological awareness: Role of speech-language pathologists. *Language, Speech, and Hearing Services in Schools, 22,* 196–203.

Catts, H., & Vartiainen, T. (1993). *Sounds abound.* East Moline, IL: LinguiSystems, Inc.

Cunningham, A. (1990). Explicit vs. implicit instruction in phonological awareness. *Journal of Experimental Child Psychology, 50,* 429–444.

Curtis, M. (1980). Development of the components of reading skill. *Journal of Educational Psychology, 72,* 656–669.

Denckla, M., & Rudel, R. (1976). Rapid automatized naming (R.A.N.): Dyslexia differentiated from other learning disabilities. *Neuropsychologia, 14,* 471–479.

DiSimoni, F. (1978). *The Token Test for Children.* Boston: Teaching Resources Corporation.

Dunn, L. M., & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test—Revised.* Circle Pines, MN: American Guidance.

Felton, R., & Brown, I. (1990). Phonological processes as predictors of specific reading skills in children at risk for reading failure. *Reading and Writing: An Interdisciplinary Journal, 2,* 39–59.

Fox, B., & Routh, D. (1983). Reading disability, phonemic analysis, and dysphonetic spelling: A follow-up study. *Journal of Clinical Child Psychology, 12,* 28–32.

Gardner, M. F. (1979). *Expressive One-Word Picture Vocabulary Test.* Novato, CA: Academic Therapy Publications.

Garvey, M., & Gorden, N. (1973). A follow-up study of children with disorders of speech development. *British Journal of Communication Disorders, 8,* 17–28.

Goldman, R., & Fristoe, M. (1986). *Goldman-Fristoe Test of Articulation.* Circle Pines, MN: American Guidance Service.

Goodman, K. (1967). Reading: A psycholinguistic guessing game. *Journal of the Reading Specialist, 6,* 126–135.

Gough, P., & Tunmer, W. (1986). Decoding, reading and reading disability. *Remedial and Special Education, 7,* 6–10.

Hall, P., & Tomblin, J. (1978). A follow-up study of children with articulation and language disorders. *Journal of Speech and Hearing Disorders, 43,* 227–241.

Hoover, W., & Gough, P. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2,* 127–160.

King, R., Jones, C., & Lasky, E. (1982). In retrospect: A fifteen-year follow-up report of speech-language disordered children. *Language, Speech, and Hearing Services in Schools, 13,* 24–32.

Levi, G., Capozzi, F., Fabrizi, A., & Sechi, E. (1982). Language disorders and prognosis for reading disabilities in developmental age. *Perceptual and Motor Skills, 54,* 1119–1122.

Lewis, B., & Freebairn, L. (1992). Residual effects of preschool phonological disorders in grade school, adolescence, and adulthood. *Journal of Speech and Hearing Research, 35,* 819–831.

Liberman, I., & Shankweiler, D. (1985). Phonology and the problems of learning to read and write. *Remedial and Special Education, 6,* 8–17.

Liberman, I., Shankweiler, D., Fischer, F., & Carter, B. (1974). Explicit syllable and phoneme segmentation in young children. *Journal of Experimental Child Psychology, 18,* 159–173.

Lie, A. (1991). Effects of a training program for stimulating skills in word analysis in first-grade children. *Reading Research Quarterly, 26,* 234–250.

Lindamood, C., & Lindamood, P. (1979). *Lindamood Auditory Conceptualization Test.* Allen, TX: DLM/Teaching Resources.

Lundberg, I., Frost, J., & Peterson, O. (1988). Effects of an extensive program of stimulating phonological awareness in preschool children. *Reading Research Quarterly, 23,* 263–284.

Lundberg, I., Olofsson, A., & Wall, S. (1980). Reading and spelling skill in first school years predicted from phonemic awareness skills in kindergarten. *Scandinavian Journal of Psychology, 21,* 159–173.

Magnusson, E., & Naucler, K. (1987). Language-disordered and normally speaking children's development of spoken and written language: Preliminary results from a longitudinal study. *Reports from Uppsala University Department of Linguistics, 16.*

Magnusson, E., & Naucler, K. (1990). Reading and spelling in language-disordered children—linguistic and metalinguistic prerequisites: Report on a longitudinal study. *Clinical Linguistics and Phonetics, 4,* 49–61.

Menyuk, P., Chesnick, M., Liebergott, J., Korngold, B., D'Agostino, R., & Belanger, A. (1991). Predicting reading problems in at-risk children. *Journal of Speech and Hearing Research, 34,* 893–903.

Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of phones arise spontaneously? *Cognition, 7,* 323–331.

Newcomer, P. L., & Hammill, D. D. (1988). *Test of Language Development-2 Primary.* Austin, TX: Pro-Ed.

Norris, J. (1989). Providing language remediation in the classroom: An integrated language-to-reading intervention method. *Language, Speech, and Hearing Services in Schools, 21,* 72–84.

Norris, J. (1991). From frog to prince: Using written language as a context for language learning. *Topics in Language Disorders, 12,* 66–81.

Padget, Y. (1988). Speech- and language-impaired three- and four-year-olds: A five-year follow-up study. In R. Masland & M. Masland (Eds.), *Preschool prevention of reading failure.* Parkton, MD: York Press.

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

Rayner, K., & Pollatsek, A. (1989). *The psychology of reading.* Englewood Cliffs: Prentice Hall.

Read, C., Zhang, Y., Nie, H., & Ding, B. (1986). The ability to manipulate speech sounds depends on knowing alphabetic writing. *Cognition, 24,* 31–44.

Rosner, J. (1971). *Phonic analysis training and beginning reading* *skills.* Pittsburgh, PA: University of Pittsburgh Learning Research and Development Center Publication Series.

Sawyer, D. (1987). *Test of Awareness of Language Segments.* Austin, TX: Pro-Ed.

Shriberg, L., & Kwiatkowski, J. (1988). A follow-up study of children with phonologic disorders of unknown origin. *Journal of Speech and Hearing Disorders, 53,* 144–156.

Smith, F. (1986). *Understanding reading.* Hillsdale, NJ: Lawrence Erlbaum.

Stanovich, K. (1988). The right and the wrong places to look for the cognitive locus of reading disability. *Annals of Dyslexia, 38,* 154–180.

Stanovich, K., Cunningham, A., & Cramer, B. (1984). Assessing phonological awareness in kindergarten children: Issues of task comparability. *Journal of Experimental Child Psychology, 38,* 175–190.

Stanovich, K., Cunningham, A., & Feeman, D. (1984). Intelligence, cognitive skills, and early reading processes. *Reading Research Quarterly, 19,* 278–303.

Stanovich, K., Nathan, R., & Vala-Rossi, M. (1986). Developmental changes in the cognitive correlates of reading ability and the developmental lag hypothesis. *Reading Research Quarterly, 21,* 267–283.

Stanovich, K., & West, R. (1989). Exposure to print and orthographic processing. *Reading Research Quarterly, 24,* 402–433.

Stark, R., Bernstein, L., Condino, R., Bender, M., Tallal, P., & Catts, H. (1984). Four-year follow-up study of language impaired children. *Annals of Dyslexia, 34,* 49–68.

Sticht, T., & James, J. (1984). Listening and reading. In D. Pearson (Ed.), *Handbook of reading research. Vol 1,* New York: Longman.

Tallal, P., Curtiss, S., & Kaplan, R. (1989). *The San Diego longitudinal study: Evaluating the outcomes of preschool impairment in language development.* Final Report, NINCDS. Washington, DC.

Thomson, M. (1984). *Developmental dyslexia: Its nature, assessment and remediation.* London: Edward Arnold.

Torgesen, J., & Bryant, B. (1993a). *Screening Test of Phonological Awareness.* Austin, TX: Pro-Ed.

Torgesen, J., & Bryant, B. (1993b). *Phonological Awareness Training for Reading.* Austin, TX: PRO-ED.

Tunmer, W., & Nesdale, A. (1985). Phoneme segmentation skill and beginning reading. *Journal of Educational Psychology, 77,* 417–427.

Vellutino, F., & Scanlon, D. (1987). Phonological coding, phonological awareness, and reading ability: Evidence from a longitudinal and experimental study. *Merrill-Palmer Quarterly, 33,* 321–363.

Vellutino, F., & Scanlon, D. (1991). The preeminence of phonologically based skills in learning to read. In S. Brady & D. Shankweiler (Eds.), *Phonological processes in literacy.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Wagner, R., Balthazor, M., Harley, S., Morgan, S., Rashotte, C., Shanner, R., Simmons, K., & Stage, S. (1987). The nature of prereaders' phonological processing abilities. *Cognitive Development, 2,* 355–373.

Wagner, R., & Torgesen, J. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101,* 192–212.

Wechsler, D. (1967). *Wechsler Preschool and Primary Scale of Intelligence.* Cleveland: Psychological Corporation.

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children—Revised.* New York: Psychological Corporation.

Werner, E. O., & Kresheck, J. D. (1983). *Structured Photographic Expressive Language Test-2.* Sandwich, IL: Janelle Publications.

Wiederholt, J. L., & Bryant, B. R. (1986). *Gray Oral Reading Test—Revised.* Austin: Pro-Ed.

Williams, J. (1980). Teaching decoding with an emphasis on phoneme analysis and phoneme blending. *Journal of Educational Psychology, 72,* 1–15.

Wilson, B., & Risucci, D. (1988). The early identification of developmental language disorders and the prediction of the acquisition of reading skills. In R. Masland & M. Masland (Eds.), *Preschool prevention of reading failure.* Parkton, MD: York Press.

Wolf, M. (1984). Naming, reading, and the dyslexias: A longitudinal overview. *Annals of Dyslexia, 34,* 87–136.

Wolf, M., Bally, H., & Morris, R. (1986). Automaticity, retrieval processes, and reading: A longitudinal study in average and impaired readers. *Child Development, 57,* 988–1000.

Woodcock, R. W. (1987). *Woodcock Reading Mastery Tests—Revised.* Circle Pines, MN: American Guidance Service.

Yopp, H. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly, 23,* 159–177.

Yopp, H. (1992). Developing phonological awareness in young children. *The Reading Teacher, 45,* 696–703.

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Contact author: Hugh W. Catts, PhD, The University of Kansas, Speech-Language-Hearing, 3031 Dole, Lawrence, KS 66045-2181.