Does Phonological Processing Distinguish Between Students Who Are More or Less Responsive to Reading Recovery?

Janet E. Spector and Paula Moore, University of Maine

ABSTRACT

We investigated the relationship between three potential markers for reading difficulties (phonemic awareness, verbal short-term memory, and rapid automatized naming) and students' responsiveness to Reading Recovery instruction. At pretest, students' most prevalent weakness was on phonemic awareness, but more than half were below average on rapid automatized naming. Students who entered Reading Recovery with low scores on phonemic awareness and verbal short-term memory were less likely than those with higher scores to be at grade level in reading by the end of Reading Recovery. Pretest performance on rapid automatized naming did not distinguish between students who were more or less responsive to the intervention.

Literacy Teaching and Learning
Volume 8, Number 2

pages 1–25

The importance of early intervention is well established; without intervention, students who lag behind their peers in first grade are apt to remain behind throughout their school careers and into adulthood (Juel, 1988; Slavin, Karweit, & Madden, 1989; Snow, Burns, & Griffin, 1998).Yet, even the most theoretically sound, research-based interventions do not bring every student up to average reading levels. Indeed, in a comprehensive review of research, Al Otaiba and Fuchs (2002) reported that nearly one-third of children who are at risk for reading difficulties and as many as one-half of children with special needs fail to achieve an average level of reading despite participation in generally effective early literacy intervention.

Few researchers have investigated the characteristics of students who are more or less responsive to early intervention to identify factors that might contribute to variability in outcome. Greater understanding of this population is needed to advance theory regarding more severe and persistent reading difficulties and, ultimately, to develop new intervention strategies, fine-tune existing interventions, and inform selection of subsequent programming for students who remain below average in reading despite participation in generally effective early interventions (Al Otaiba & Fuchs, 2002).

The purpose of the present study was to investigate characteristics that distinguish between Reading Recovery students who accelerate within 20 weeks and those who do not make accelerated progress and are referred on for further services at the end of the program. We begin with a review of research on factors associated with success in Reading Recovery as well as more general research on characteristics of students with reading difficulties. Our review enabled us to identify what is currently known about differences between more and less responsive Reading Recovery students and to design a study to expand the knowledge base.

LITERATURE REVIEW

One factor previously examined as a potential mediator of success in Reading Recovery is entry-level literacy skills. Although Reading Recovery participants represent children having the greatest difficulty learning to reading in their class, they vary in print-related skills. Clay and Tuck (1991) investigated whether children who begin with the lowest skills in reading and writing are least likely to achieve grade-level standing within 15 to 20 weeks. To address this question, they compared discontinued and referred Reading Recovery participants on entry-level performance on reading and writing. (Discontinued students are those who are successful in achieving grade-level standing as a result of participation in the program. Referred students do not successfully discontinue; that is, they complete a full series of Reading Recovery lessons but do not achieve grade-level standing.)

Not surprisingly, many Reading Recovery students in the Clay and Tuck sample had entry scores close to zero on Reading Recovery reading and writing assessments. Although they did not test the statistical significance of mean differences between discontinued and referred students, descriptive statistics suggest a relationship between entry-level scores and the probability of being either discontinued or referred. For example, the probability of being discontinued increased from a low of .25 for students with an entering text level of zero to a high of .94 for those entering at Text Level 5 or above. Clay and Tuck also noted, however, some children with zero scores on entry measures met the program goal of accelerative progress, while children with relatively strong entry-level scores were referred on for long-term intervention due to slow progress.

Furthermore, examination of the correlations between performance on entry-level measures and length of time to discontinue indicate that entry-level performance accounted for only about 12–38% of the variance in time needed to discontinue, depending on the measure. Among referred students, entry-level performance accounted for 0–7% of the variance in length of time to referral. In short, Clay and Tuck's results indicate that progress in Reading Recovery was influenced, but was not fully accounted for, by entry-level print skills.

What factors in addition to print skills differentiate between students who are more and less responsive to Reading Recovery? In the last 25 years, researchers have made considerable progress in mapping the relationship between phonemic awareness and reading acquisition. Although there is some variation from study to study in the definition of phonemic awareness, the term generally is used to denote the ability to perceive spoken words as a sequence of sounds. The word *fish*, for example, comprises three phonemes: /f/, /i/, and /sh/. Phonemic awareness has been measured by performance on a wide range of tasks including rhyming; isolating beginning, medial, and ending sounds; breaking down words into their component sounds; saying words with target sounds deleted; and producing invented spellings.

An extensive body of correlational and experimental research indicates that phonemic awareness plays a critical role in determining how well children learn to read during the first 2 years of instruction (see reviews in Adams, 1990; National Institute of Child Health and Human Development, 2000; Snow et al., 1998). Furthermore, numerous studies of children with severe and persistent reading difficulties indicate that the vast majority demonstrate weaknesses on a broad range of measures that, like phonemic awareness, require processing of phonological information (Stanovich, 1992). Three variables that receive considerable support as potential markers for reading difficulties are phonemic awareness, verbal short-term memory (e.g., recalling a series of orally presented stimuli; Torgesen, Wagner, & Rashotte, 1994), and rapid automatized naming (e.g., speed of naming familiar stimuli presented in a visual array; Wolf &

Bowers, 1999). Some theorists think that these variables tap three related clusters of phonological processing abilities: phonological sensitivity, phonological memory, and phonological naming, respectively (Torgesen & Wagner, 1998; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997; Whitehurst & Lonigan, 2001). Proponents of this position hypothesize that reading difficulties are generally the result of a phonological core deficit.

Other theorists, in contrast, view rapid automatized naming as a distinct construct, referred to as naming speed (e.g., Bowers & Wolf, 1993; Wolf & Bowers, 1999; Wolf, Bowers, & Biddle, 2000). To support this view, they investigate the unique contribution of tasks such as serial naming of letters, numbers, objects, or colors to reading performance, above and beyond the contribution of phonological analysis tasks such as phoneme segmentation.

Although the theoretical rationale for the correlation between naming speed and reading is still the subject of considerable research and debate, a growing body of research on reading difficulties suggests that slow naming speed inhibits the development of word recognition (Wolf & Bowers, 1999; Wolf et al., 2000). Does naming speed distinguish between students who are more versus less responsive to Reading Recovery? At present this question remains unanswered. Although naming speed tasks have long been used in research on a wide range of cognitive and linguistic abilities and within a variety of educational contexts, research on Reading Recovery has not yet included this variable.

Furthermore, only a few studies address phonological analysis within the context of Reading Recovery; those that do focus almost exclusively on phonemic awareness. For example, Iversen and Tunmer (1993) compared (a) children who received regular Reading Recovery training, (b) children who received Reading Recovery training that included word attack skills as part of the lesson, and (c) children who received an alternative intervention. (Interestingly, the type of word attack activities that Iversen added to Reading Recovery lessons had already become a standard feature of Reading Recovery lessons by the time the study was published [Hatfield, 1994; North America Trainers Group, 2002].)

Iversen and Tunmer (1993) found no significant differences at pretest between the three groups on print skills or phonemic awareness (phoneme segmentation and phoneme deletion). At posttest, however, both Reading Recovery treatment groups outperformed students in the alternative intervention on all measures, including the two measures of phonemic awareness. This result suggested that participation in Reading Recovery did, in fact, have a positive effect on phonemic awareness; however, because both Reading Recovery treatment groups had a 100% success rate, the study was unable to elucidate factors underlying lack of responsiveness to Reading Recovery.

Stahl, Stahl, and McKenna (1999) also reported positive effects of Reading Recovery on phonemic awareness. They compared a small group of Reading

Recovery students (n = 11) to a comparison group (n = 19) waiting to receive Reading Recovery. At pretest, the two groups were equivalent on three measures: Letter Identification, Hearing Sounds in Words, and the Yopp-Singer Test of Phoneme Segmentation (Yopp, 1995), a measure of phonemic awareness. By the 16th week of the study, approximately half of the Reading Recovery participants had successfully discontinued. Results revealed that Reading Recovery students, whether discontinued or not, experienced significantly greater gains than comparison students on all three of the above measures, although the effect size for phoneme segmentation was small (η^2 = .13). Perhaps because of the small sample size, Reading Recovery results were not broken down by treatment outcome, so it was not clear whether superior gains in phonological sensitivity were experienced by both discontinued and not-discontinued Reading Recovery students.

Does phonological processing distinguish between students who are more or less responsive to Reading Recovery instruction? Two Reading Recovery studies compared more versus less successful Reading Recovery students on phonological processing. As part of a larger evaluation study, researchers (Center, Wheldall, Freeman, Outhred, & McNaught, 1995) compared eight Reading Recovery students who they identified as fully recovered (i.e., at grade level on all posttest measures) to eight who they considered unrecovered (i.e., below grade level on most posttest measures). They concluded that the recovered students scored much higher than the unrecovered group on pretest measures of both phonemic awareness and phonological recoding (word attack) and slightly higher on syntactic awareness; however, the means and standard deviations for recovered and unrecovered students reported in Table 14 (p. 260) of the paper are incompatible with means and standard deviations reported earlier for the total Reading Recovery sample (see Table 3 of the paper, p. 251). Correspondence with the study's first author confirmed the probability of errors in Table 14, but affirmed the pattern of results on page 259 of the paper (Y. Center, personal communication, October 27, 2003).

As part of a longitudinal study conducted in New Zealand, Chapman, Tunmer, and Prochnow (2001) compared entry-level performance of more- and less-successful Reading Recovery students as defined by scores on a context-free word recognition test, the Burt Word Test. They reported that the more-successful students entered the program with higher scores than the less-successful students on pseudoword decoding, phoneme segmentation, analogical transfer, and invented spelling.

In summary, only a handful of studies have investigated phonological processing within the context of Reading Recovery. Furthermore, no study has compared more- versus less-responsive students on all three potential markers for persistent reading difficulties: phonemic awareness, verbal short-term memory, and naming speed. We aimed to fill this gap in the literature by investigating the relationship between entry performance on these variables and responsiveness to Reading Recovery instruction. Specifically, we addressed the question: Does phonological processing distinguish between Reading Recovery students who are more versus less responsive to intervention?

METHOD

Reading Recovery teachers throughout the state (*n* = 350) were invited by letter to participate in the study. A total of 37 teachers from 31 schools participated in training sessions to learn data collection procedures. Those who volunteered for the study tended to be highly experienced professionals. Length of employment in education ranged from 7 to 37 years (*M* = 18.5, *SD* = 6.61), while length of Reading Recovery experience ranged from 2 to 8 years (*M* = 4.65, *SD* = 1.71). Participants also varied in educational background, with about half (*n* = 19) holding degrees beyond the bachelor's level (master's degree, *n* = 9; post-master's degree, *n* = 10).

Approximately two-thirds of the schools represented in the sample were located in towns with populations less than 10,000 (*n* = 20). All but one of the remaining schools were in towns with populations ranging from 10,100 to 49,999. Only one school was located in a densely populated area (population size = 50,000 to 250,000). Length of school participation in Reading Recovery ranged from 3 to 9 years (*M* = 5.86, *SD* = 1.81).

In September, Reading Recovery teachers randomly selected two to four children from their caseloads. To be eligible for Reading Recovery, children had to score within the lowest stanines of their first-grade class on measures of reading and writing. Teachers tested students on the Observation Survey (Clay, 1993) and phonological processing at two points: entry into and exit from Reading Recovery. Exit testing occurred when students were judged by their teachers to be reading at grade level and capable of continuing to progress without additional tutorial support, or when students had been in the program for the maximum number of weeks allowed (around 20 weeks), even if they had not yet achieved grade-level standing (whichever occurred first).

Participants

In the fall, teachers collected data on 135 Reading Recovery students. All were first-round Reading Recovery participants, identified as the neediest readers in each school's pool of first graders. Five students (4%) were not available for posttesting: four moved and one was withdrawn from the program by the parent. Due to unforeseen testing difficulties experienced by teachers, approximately 18% of the remaining students (n = 24) were missing scores on more than one of the phonological processing posttests. We performed follow-up interviews with teachers to learn more about problems that fell into the latter category. The most common factors were competing demands on the teacher's time and misunderstanding of timeline or data collection procedures for the phonological measures.

We performed *t*-tests on all pretest measures to determine whether there were systematic differences between students who were and were not included in statistical analyses. Results indicated no significant differences between excluded and included students on any pretest measures, indicating that the final sample was representative of the initial group of participants.

The age of students at the time of fall testing ranged from 71 to 94 months (M = 78.61 months, SD = 5.02), although approximately 90% were between 6-0 and 7-0 years old. The sample comprised approximately twice as many males (n = 70) as females (n = 36), a finding that is not surprising given the over-representation of males in most samples of lower-performing readers, but is surprising here given that males are not over-represented in the national Reading Recovery sample (cf. Gómez-Bellengé, Rodgers, & Fullerton, 2003). Consistent with the demographics of the state, the vast majority of Reading Recovery students in the study were White (91%), native English speakers (94%). The only information regarding socioeconomic status came from lunch cost statistics, available for only 59% of the sample. Among the 63 students for whom these data were available, 28 (44%) received free or reduced-cost lunch, while 35 (56%) paid the regular price for lunch. No information was available regarding the methods used to teach reading in first-grade classrooms of participating students.

Reading Recovery program length and intensity varied across the sample. The vast majority of participants (82%) remained in the program between 19 and 22 weeks (M = 20.4 weeks, SD = 1.88). The number of instructional sessions per week also varied from a low of 2.6 to a high of 4.2 (M = 3.61, SD = .36). Overall, students in the sample received an average of 36.7 hours of instruction.

Our sample selection procedure varied from that used in many previous studies of reading difficulties. Any student identified by school professionals for first-round Reading Recovery service was eligible to participate in the study. Furthermore, we did not administer any intelligence or verbal ability tests to participants in the study. This decision was motivated by the need to minimize testing time for participating Reading Recovery teachers and students, and it was supported by research indicating that general intelligence and verbal ability do not predict individual differences in rate of reading acquisition after controlling for differences in phonological abilities (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; Torgesen et al., 1999; Vellutino et al., 1996).

Measures

Students were assessed on the Observation Survey (Clay, 1993), the instrument used to identify students for Reading Recovery and evaluate progress in the program, and three measures of phonological processing: phonemic awareness, verbal short-term memory, and naming speed.

Letter Identification

Testers asked children to identify 54 characters, the upper- and lower-case standard letters as well as the print form of *a* and *g*. Acceptable responses included letter names, letter sounds, or a word beginning with the letter. The test was scored for number of characters identified correctly. Previous research indicated high reliability (Cronbach's $\alpha = .95$) and a positive correlation with word recognition ($r = .85$; Clay, 1993).

Hearing and Recording Sounds in Words

Examiners read a short sentence or two and asked children to write the words that they heard. Scores indicate the number of sounds that were represented appropriately (maximum score = 37). Credit is awarded based on accuracy in representing phonemes rather than on spelling accuracy, following the guidelines in Clay (1993). Previous research established the internal consistency of the measure ($\alpha = .96$) and yielded positive correlations ($r = .79$) with word recognition (Clay, 1993).

Text Level

Children read orally a series of increasingly more difficult texts that they had not seen before. Testers provided a minimal, scripted introduction and recorded reading accuracy. The texts used for testing were not used in instruction, nor were they created for Reading Recovery. Texts were drawn from established basal systems and provide a stable measure of reading performance (Askew, Fountas, Lyons, Pinnell, & Schmitt, 1998). Scores on this measure indicate the highest level at which the student achieves at least 90% accuracy in word recognition. Previous reliability studies utilizing the Rasch rating scale yielded a person separation reliability of .83 and an item separation reliability of .93 (Pinnell, Lyons, DeFord, Bryk, & Seltzer, 1994).

Ohio Word Test

Examiners asked children to read aloud a list of 20 high-frequency words from the Dolch list. Words were taken from three different reading levels: preprimer,

primer, and Grade 1[2] (i.e., second half of Grade 1). Scores reflected the number of words identified correctly. Three alternate words lists were available for testing and retesting. Fall testing used List 1 and exit testing used List 2. Previous studies established the internal consistency of the measure (α = .92; Clay, 1993).

Concepts About Print

After reading a short book, the examiner asked the child to perform 24 tasks that reflect knowledge about the way spoken language is put into print (maximum score = 24). Two versions of the book were used for testing, one at program entry *(Sand)* and one at program exit *(Stones)*. Internal consistency is estimated at .80 or above (Day & Day, 1980). Test-retest reliability coefficients range from .73 to .89 and, according to Clay (1993), there is a high correlation with word recognition at age 6 (r = .79). Scores on this measure indicated the number of tasks that the child performed correctly.

Writing Vocabulary

On this test, testers asked children to write all of the words they knew within a 10-minute span. The test was scored for number of items written correctly. Previous investigations provide evidence of strong test-retest reliability (.97) and positive correlations (.82) with reading (Clay, 1993).

Phonemic Awareness

A wide range of tasks can be used to assess phonemic awareness (PA), including rhyming, alliteration, segmentation, and deletion. We chose the Yopp-Singer Test of Phoneme Segmentation (Yopp, 1988) on the basis of results reported by Yopp (1988) in her study of the reliability and validity of 10 PA measures. In that study, factor analysis indicated that PA comprises two factors: simple and complex. Simple PA is generally regarded as a precursor to reading while complex PA is more often viewed as an outcome of reading. The Yopp-Singer provided the most reliable measure of simple PA (α = .95). In addition, the test correlated positively with a wide range of literacy measures including word attack, vocabulary, comprehension, and spelling through Grade 6 (Yopp, 1995).

On the Yopp-Singer test, the examiner asked students to pronounce, in order, each of the sounds in a spoken word. Sounds, not letter names, were the appropriate response. Corrective feedback was given on trial items and after any incorrect responses throughout the 22-item test.

Using Yopp's approach, we scored the test for number of words that were segmented correctly. The maximum score possible was 22; however, we found that 41% of our sample scored zero at pretest. To alleviate the substantial floor effect, we created a partial credit measure, awarding one point for each sound isolated. For example, on the word *zoo*, the response /zu/ – /u/ received one point (for the phoneme /u/). The maximum score possible using partial credit scoring was 56. We used partial-credit scoring (number of segments correct) in conducting inferential statistical analyses because scores more closely approximated a normal distribution; however, for descriptive purposes we include means and standard deviations for both the conventional scoring system (i.e., number of items correct) and partial-credit scoring (i.e., number of segments correct) in the tables.

Verbal Short-Term Memory

We assessed verbal short-term memory (VSTM) using Memory for Words from the Woodcock-Johnson Psychoeducational Battery-Revised (Woodcock & Johnson, 1989). The test required students to repeat lists of unrelated words in the correct sequence. Raw scores indicated the number of item strings repeated correctly. These raw scores were then transformed into standard scores (M = 100, SD = 15) using age-based norms provided by the test publisher. The test manual reported age-corrected test-retest reliability of .65, with trait stability of true scores of .80. Internal consistency was estimated at .85 and .83 for 6- and 7-year-olds, respectively. Factor loadings for students in kindergarten through Grade 3 were high and positive on *Gsm* (.70), supporting construct validity.

Rapid Automatized Naming

Naming speed tasks require students to label as quickly as possible highly familiar stimuli in randomly ordered arrays. Most commonly, tasks present colors, objects, letters, or digits, either in blocks of a single stimulus type (e.g., colors only, digits only) or in mixed blocks. At entry to Reading Recovery, the majority of children in the present study had yet to master letter names. Teachers also reported that digits remained problematic for many Reading Recovery participants. We opted, therefore, to assess naming speed using rapid automatized naming (RAN) colors and objects only.

We selected a two-part test taken from the *Comprehensive Test of Phonological Processes* (Wagner, Torgesen, & Rashotte, 1999): Rapid Automatized Naming of Colors and Objects. First, children named colored squares arranged in rows while the examiner timed them. After that, they named a set of common objects (e.g., key, fish, boat) arranged in rows. Raw scores reflected time taken to name both colors and objects. Because of the developmental nature of the tasks (correlations between age and RAN were -.67 for color naming and -.68 for object naming), we converted raw scores to standard scores (M = 100, SD = 15) using age-based norms in the test manual (Wagner, Torgesen, & Rashotte, 1999).

Previous reliability studies reported by the test's authors indicated favorable results using procedures appropriate for timed tests. Coefficient alphas were high for 6- and 7-year-olds, .89 and .87 respectively. In addition, stability over time was estimated at .70 and interscorer reliability was also strong (.99). Significant correlations between RAN in kindergarten and first grade and scores on the Woodcock Reading Mastery Tests-Revised one year later (.66 and .70 respectively) supported claims regarding predictive validity.

Data Analysis

To investigate the relationship between entry-level performance on three potential markers for reading difficulties and responsiveness to Reading Recovery instruction, analyses focused on differences between students who were program-identified as discontinued and those who were not discontinued. Discontinued students achieved grade-level standing by the end of lessons, while not-discontinued students completed a full Reading Recovery program but were recommended for further services. First, we conducted analyses to establish the comparability of discontinued and not-discontinued students on demographics, program length and intensity, and teacher experience. Second, we investigated possible entry-level differences between discontinued and not-discontinued students on the Observation Survey and on PA, VSTM, and RAN. Third, we used logistic regression to identify the independent effects of PA, VSTM, and RAN on the odds ratio for being discontinued, controlling for individual differences in reading at entry into Reading Recovery.

FINDINGS

Comparability of Discontinued and Not-Discontinued Students on Demographics, Teacher Experience, and Program Delivery

Among the 106 students who participated in the study, 49% achieved the program goal of accelerative progress in reading and were successfully discontinued from Reading Recovery. The remaining 51% did not meet this goal despite participation in a full Reading Recovery program. Most of these students were recommended for other services such as small-group instruction in reading (n = 36) or special education (n = 10).

While the rate of discontinuing in our sample was virtually identical to the statewide average for first-round students (i.e., students entering Reading Recovery in September and October) in the year in which the study was conducted, the rate is significantly lower than the most recently available national average (63%) for first-round service (Gómez-Bellengé, Rodgers, & Fullerton, 2003). On the one hand, it is to be expected that some states and research projects will yield success rates that are higher or lower than average. At the same time, we acknowledge the uncertainty of generalization of our results to Reading Recovery projects with higher rates of discontinuing.

What entry-level characteristics distinguished more-responsive versus less-responsive Reading Recovery students? The first step in our analyses was to rule out possible confounding between discontinued status and uncontrolled student, program, and teacher characteristics. Chi-square analysis compared groups on gender. Results revealed that discontinued and not-discontinued students were comparable on proportion of males and females, χ^2 (1, N = 106) = .12, p = .73. More specifically, discontinued students comprised 69% males, while not-discontinued students comprised 66% males. We did not attempt chi-square analyses to compare the two groups on English-language background, race/ethnicity, or special education status due to the small numbers of students in some categories. Descriptively, however, the few students who were not Caucasian or from native-English-speaking homes were distributed fairly evenly across discontinued and not-discontinued statuses. Similarly, among the 59% for whom we had lunch-cost data, there were no marked differences between discontinued and not-discontinued students in proportion who received free or reduced-price lunch. Also, students who received special education services prior to Reading Recovery entry were just as likely to discontinue as those who had not received these services.

We used *t*-tests to contrast discontinued and not-discontinued outcome status on other student, program delivery, and teacher characteristics. As can be seen in Table 1, results indicated that discontinued and not-discontinued students did not differ in mean age. With respect to program delivery, the two groups were comparable on total number of weeks in the program, total number of Reading Recovery sessions, and average number of Reading Recovery sessions per week. In addition, teacher experience was unrelated to outcome; that is, there were no mean differences between discontinued and not-discontinued students in teacher's length of service in Reading Recovery or teacher's length of employment in education. Together, these analyses suggested that observed differences in status at the end of Reading Recovery were not the result of pre-existing differences between students on age, gender, or socioeconomic status, nor were they the result of significant differences in program length and intensity or teacher experience.

Entry-Level Differences Between Discontinued and Not-Discontinued on Reading, Writing, and Phonological Processing

The second set of analyses that we conducted examined differences between discontinued and not-discontinued students on the Observation Survey and three measures of phonological processing. Alpha was set at .005 for each individual comparison to achieve a familywise alpha of .05 across nine tests comparing discontinued and not-discontinued students on reading, writing, and phonological processing.

Observation Survey

Previous research by Clay and Tuck (1991) found that students with lower entry scores on reading and spelling were somewhat less likely than students with higher entry scores to discontinue. Did discontinued students in the present study enter Reading Recovery with more advanced literacy skills than students who did not discontinue? Pretest means and standard deviations are

Table 1. Student, Teacher, and Program Delivery Characteristics of Discontinued and Not-Discontinued Reading Recovery Students

	Discontinued (n = 51)		Not-Discontinued (n = 55)		
	M	*SD*	*M*	*SD*	t^{a}
Student Characteristic					
Age (in months)	78.25	4.95	78.95	5.10	-.71
Teacher Experience					
Years Employed in Reading Recovery	4.86	1.69	4.33	1.77	1.58
Years Employed in Education	18.29	6.11	17.84	7.05	0.36
Program Delivery					
Total Weeks in Reading Recovery	20.41	2.34	20.38	1.33	0.08
Total Reading Recovery Sessions	74.86	10.69	72.58	9.12	1.18
Sessions Per Week	3.67	0.35	3.55	0.36	1.59

[a] No *t*-ratio was statistically significant, indicating that Discontinued and Not-Discontinued did not differ on any of these variables.

shown in Table 2. As can be seen, students in both groups failed to identify many letters and were able to record only a few sounds heard in words. The vast majority of students spelled correctly fewer than six words and almost half scored zero on text level and word recognition. Because of the significant floor effect on Text Level and Ohio Word Test, these subtests were excluded from pretest analyses using parametric procedures. As can be seen in Table 2, *t*-test results indicated that the two groups were comparable on Concepts About Print, Hearing and Recording Sounds in Words, Writing Vocabulary, and Letter Identification.

Because of substantial floor effects on Text Level and Ohio Word Test, we compared discontinued and not-discontinued students on proportion who

Table 2. Pretest Means of Discontinued and Not-Discontinued Reading Recovery Students

	Discontinued (n = 51)		Not-Discontinued (n = 55)			
Measure	*M*	*SD*	*M*	*SD*	*t*	*d*
Letter Identification	39.59	9.60	36.11	10.95	1.73	.33
Hearing Sounds in Words	8.24	5.48	6.38	5.96	1.47	.33
Ohio Word Test	.65	1.00	.51	1.02		
Concepts About Print	11.50	2.25	10.55	3.34	1.75	.33
Writing Vocabulary	5.55	3.03	3.93	3.00	2.76	.54
Text Level	.72	.69	.61	.66		
Phonemic Awareness						
Items Correct	4.00	4.01	2.09	3.09		
Segments Correct	18.00	13.44	10.73	10.59	3.10**	.57
VSTM	101.96	11.35	94.36	11.95	3.35**	.65
RAN	85.12	13.92	80.35[a]	15.50	1.65	.33

Note: Means on VSTM and RAN are standard scores (*M* = 100, *SD* = 15); means on Text Level indicate highest level read with at least 90% accuracy; other means indicate number correct. *T*-tests were not computed for Ohio Word Test, Text Level, or PA Items Correct because of a marked floor effect. *d* = Cohen's effect size; RAN = rapid automatized naming; VSTM = verbal short-term memory.

[a] *n* = 54

** p <.004

scored zero on each of these measures (i.e., rather than on mean score). The results of chi-square analyses revealed no significant differences. On the Ohio Word Test, 63% of discontinued and 71% of not-discontinued students were unable to read any words correctly, χ^2 (1, N = 106) = .80, p = .37, and 69% of discontinued and 73% of not-discontinued students scored below Level 1 on Text Level, χ^2 (1, N = 106) = .21, p = .64. Overall, then, the two groups displayed comparable entry-level reading and writing skills, as measured by tasks in the Observation Survey (Clay, 1993).

Phonological Processing

Pretest means and standard deviations for PA, VSTM, and RAN are also displayed in Table 2. PA was not assessed on a norm-referenced test, but comparison to other research samples indicated that students in the present study were low performers. As can be seen in Table 2, the typical first-round Reading Recovery student in our sample segmented correctly only about three items on the Yopp-Singer. In contrast, previous studies that used the Yopp-Singer to assess segmentation ability at the end of kindergarten reported average scores around 11 or 12 items correct (Spector, 1992; Yopp, 1988). Furthermore, the present sample was relatively low on PA even in comparison to another Reading Recovery sample that was assessed on the Yopp-Singer. Stahl et al. (1999) reported a pretest mean of 5.36 items correct (*SD* = 6.13) for entering first-grade Reading Recovery students in their study and 6.26 items correct (*SD* = 5.06) for the control group.

Application of criterion-referenced standards also confirmed that the majority of students in our sample entered Reading Recovery with poor PA. From their review of the literature, Torgesen and Mathes (2000) concluded that by the end of kindergarten, most students can isolate and pronounce the beginning sound of a word, and by mid–first grade they can isolate and pronounce all the sounds in two- or three-phoneme words. None of the beginning first graders in our sample of first-round Reading Recovery students demonstrated mastery of segmentation of two- and three-phoneme words (defined as a score of 80% correct on the Yopp-Singer) and almost three-quarters of the sample segmented correctly less than 20% of the items on the test, despite corrective feedback after each item attempted. Indeed, 44 students were unable to segment correctly any items on the test.

Although we did not ask students to identify initial sounds of words, examination of performance based on our partial-credit scoring system for the Yopp-Singer indicated that more than half of our sample had difficulty isolating even one sound per word, and a small number (n = 12) scored zero even on partial-credit scoring. Students who achieved a raw score of 18 or more on the partial-credit measure identified, on average, at least one sound correct on 80% of the items on the test (n = 41). We considered it likely that these students met the kindergarten standard identified by Torgesen and Mathes (2000). In contrast, students with scores lower than that lacked proficiency in isolating even one sound per word, demonstrating insufficient mastery of the end-of-kindergarten standard.

As can be seen in Table 2, discontinued students outperformed those not-discontinued on PA, both on conventional Yopp-Singer scoring (i.e., number of items correct) and on partial-credit scoring (i.e., number of segments correct). Specifically, discontinued students scored more than one-half of a standard deviation higher than those not-discontinued on this measure. Because of a floor effect, particularly when scored for number of items correct, we also compared the two groups on proportion who were unable to segment any items correctly. Descriptively, a relatively higher percentage of not-discontinued students (53%) than those discontinued (29%) scored zero on full segmentation of two- and three-phoneme words, although the two groups were comparable in proportion who scored zero on the partial-credit measure: discontinued students = 6%, not-discontinued = 16%.

Discontinued students also outperformed not-discontinued on VSTM, a norm-referenced test with a standard score mean of 100 and *SD* of 15. As can be seen in Table 2, the mean standard score for discontinued students was solidly average, while the mean score for not-discontinued students was somewhat below average. Converting standard scores to percentiles, the results indicated that the typical discontinued student was at the 52nd percentile in comparison to age-based national norms, while the typical not-discontinued student was at the 27th percentile.

Both discontinued and not-discontinued students appeared weak on RAN, with mean standard scores that were 1.3 *SDs* below age-based norms, respectively (16th percentile for discontinued; 10th percentile for not-discontinued students). As can be seen in Table 2, however, *t*-test results indicated that the difference between the two groups on RAN was not statistically significant.

Logistic Regression

Analyses already described identified two potential markers for reading difficulties on which discontinued and not-discontinued students differed at entry into Reading Recovery: PA and VSTM; however, these results do not take into consideration the confounding influences, or overlap, among the measures. As the third and final step in our analyses, we turned to logistic regression. This analysis enabled us to test the independence of the relationship between our phonological processing measures and discontinued status. In conducting the analysis, we included Letter Identification in the regression equation to control for individual differences in reading skills at entry into Reading Recovery. We chose

Letter Identification because alphabetic knowledge correlates highly with later reading skills and because there was not a floor effect on this variable, as was the case for Ohio Word Test or Text Level. The dependent measure was end-of-program status (not-discontinued or discontinued) and the independent variables were PA, VSTM, RAN, and Letter Identification. We entered all four variables into the regression equation simultaneously to identify the effects of each variable, holding constant (i.e., controlling for) the effects of the other three. Alpha was set at .05.

The results of the analysis indicated that the overall model provided a better fit to the data than a model that did not include our predictors (i.e., the constant-only model). As can be seen in Table 3, statistical tests for individual measures revealed that PA and VSTM, but not Letter Identification or RAN, each had a significant effect on status at the end of Reading Recovery. It is important to note that βs in logistic regression do not have a straightforward interpretation. Unlike βs in ordinary least squares regression, they can not be used to compare the magnitude of effects across variables. The values shown in

Table 3. Results of Logistic Regression Showing the Effects on the Odds Ratio for Discontinuing on Four Pretests (n = 105)

Overall Model Evaluation	
-2 log likelihood	125.920

Model χ^2	*df*	*p*
19.55	4	.001

Pretest	β	SE_β	Wald's χ^2	*df*	*p*	e^β
LI	.02	.02	1.27	1	.26	1.02
PA	.04	.02	4.40	1	.04	1.04
RAN	.02	.01	1.29	1	.26	1.02
VSTM	.05	.02	6.14	1	.01	1.05
Constant	-7.77	2.41	10.36	1	.00	--

Note: e^β = odds ratio; LI = Letter Identification; PA = Phonemic Awareness; RAN = rapid automatized naming; VSTM = Verbal Short-Term Memory the last column of Table 3, e^{β}, are the most readily interpretable. These values indicate the odds ratio associated with each variable. Values less than 1 indicate reduced odds, while values greater than 1 indicate increased odds.

For example, the odds ratio for PA is 1.04, a value greater than 1. This value indicates that higher scores on PA were associated with increased likelihood of being discontinued. Specifically, holding VSTM, RAN, and Letter Identification constant, the odds ratio for discontinued status increased by 4% with each additional segment correctly isolated on the Yopp-Singer. In the case of VSTM, holding PA, RAN, and Letter Identification constant, the odds ratio for non-discontinued increased by 1.05 (i.e., 5%) with each additional standard score point increase on VSTM.

Logistic regression also enabled evaluation of the magnitude of observed effects by indicating the number of students who were accurately classified as discontinued or not-discontinued using measures included in the regression equation. Specifically, measures of PA and VSTM classified 69% of the students who failed to discontinue and 65% who discontinued, yielding an overall rate of 67%. Among the 33% who were incorrectly classified, 16% were expected to discontinue but did not do so, while 17% were expected not to discontinue but actually did discontinue.

DISCUSSION

Previous research has yielded limited knowledge regarding factors that distinguish between students who are more versus less responsive to Reading Recovery instruction. The present study compared discontinued and not-discontinued students on three phonological processing variables identified as potential markers for persistent reading difficulties: phonemic awareness, verbal short-term memory, and naming speed. The study extends the knowledge base on both Reading Recovery and reading difficulties with two findings.

Prevalence of Low Scores on Phonological Processing Variables

First, the vast majority of students identified by their schools as eligible for first-round Reading Recovery service entered with characteristics that are associated with persistent reading difficulties. At entry into Reading Recovery, 92 out of 106 first-round Reading Recovery students (87%) presented with poor performance on at least one out of three markers. The most prevalent weakness, observed in 67% of the first-round students in our sample, was on phoneme segmentation, a measure of PA; however, more than half (56%) scored one or more *SD*s below the mean for their age on RAN, and 36% scored more than two *SD*s below the mean on this measure. Although a few studies have identified poor phonemic awareness as a potential obstacle to success in Reading

Recovery (Center et al., 1995; Chapman et al., 2001; Iversen & Tunmer, 1993; Stahl et al., 1999), the inclusion of RAN in the present study makes a unique contribution to the Reading Recovery knowledge base. Interestingly, the prevalence of naming-speed difficulties that we observed in our sample was comparable to that reported by other investigators (Catts, Gillespie, Leonard, Kail, & Miller, 2002).

Similarly, the link between VSTM and responsiveness to Reading Recovery extends the generalizability of a long line of research on the relationship between phonological memory and reading difficulties (e.g., Morris et al., 1998; Torgesen, 1977, 1996; Torgesen & Houck, 1980; Torgesen & Wagner, 1998; Wagner & Torgesen, 1987). To the best of our knowledge, though, ours is the first study to report an association between VSTM and progress in Reading Recovery. Although only about one-third of the sample scored at or below the 25th percentile on this measure (i.e., standard score of 90 or less), those with low scores were more than twice as likely to be recommended for further action than those with scores that were closer to the norm group mean.

Our findings with respect to PA are also consistent with previous research linking phonological sensitivity and reading. Students who entered Reading Recovery unable to segment any items on the Yopp-Singer were twice as likely to be recommended for further action at the end of their programs as those who were able to segment correctly at least one item on the test.

Lack of Relationship between Entry-Level RAN and Progress in Reading Recovery.

The second key finding was that naming speed did not distinguish between students who were more or less responsive to Reading Recovery instruction. The absence of a significant relationship between RAN and progress in Reading Recovery is more difficult to interpret, particularly given the prevalence of low scores on RAN at pretest. As mentioned earlier, first-round Reading Recovery students who successfully discontinued from Reading Recovery and those who did not discontinue entered Reading Recovery with equivalent mean standard scores on RAN.

Re-examination of the research on RAN suggests several possible explanations for the unexpectedly low correlation between RAN and reading progress in the present study. First, many previous naming-speed studies controlled for the effects of IQ on reading progress. We are unable to determine whether the effects of RAN would have been more powerful after partialing out the effects of IQ because we did not assess students' cognitive ability.

Second, it is possible that our dependent measures were not sensitive to the dimensions of reading and spelling that correlate most highly with RAN. While PA has been identified as a major factor underlying development of word attack skills and phonological processing, RAN has been linked more closely with sight word recognition and orthographic processing (Manis, Doi, & Bhadha, 2000; Wolf et al., 2002).

Measures of orthographic processing typically involve tasks that can not be performed simply by decoding or encoding predictable letter-sound correspondences. For example, students may be asked to spell the word *cough* or to identify which of two letter strings is a real word, *hope* or *hoap*. To perform these tasks, students must access word-specific or orthographic knowledge in addition to using phonological cues. Although the Observation Survey requires students to read and spell some items that require application of word-specific knowledge, the test is not scored in a way that separates the contribution of orthographic and phonological processes. In other words, we might have found more substantial effects of RAN on posttest performance had we included tasks more sensitive to individual differences in orthographic processing.

Finally, we might have found more powerful effects of RAN had we assessed speed of naming letters or digits rather than colors and objects. Previous research on RAN has yielded less consistent results regarding the predictive strength of naming speed for nonsymbolic stimuli like colors and objects than has been the case for symbolic stimuli like letters and digits. Although some studies document significant correlations between RAN for objects or colors and future reading (Cornwall, 1992; Fawcett & Nicholson, 1994; Korhonen, 1995; Meyer, Wood, Hart, and Felton, 1998a, 1998b; Scarborough, 1998a, 1998b), other investigators conclude that naming speed for non-symbolic stimuli is an inconsistent predictor of reading (Badian, 1998; Manis, Doi, & Bhadha, 2000; Wagner et al., 1994; Wimmer, 1993; Wolf, 1991; Wolf, Bally, & Morris, 1986).

Among the studies that found no association between reading and RAN for objects and colors, one in particular addressed a question similar to ours; that is, what variables distinguish young poor readers who are easily remediated from those who are more resistant to remediation? From their study of average and tutored readers, Vellutino et al. (1996) concluded that below-average first-grade readers who were less responsive to early reading tutoring (i.e., very-low-growth readers) did not differ from below-average first-grade readers who were more responsive to early reading intervention (i.e., very-good-growth readers) on naming speed for objects and colors, but they did differ on naming speed for letters and numbers.

Clearly, more research is necessary to untangle the web of inconsistent findings vis–à–vis the relationship between RAN and progress in beginning reading. From a practical perspective, the lack of consistency across studies suggests that schools should exercise considerable caution in using measures of naming speed for decision making. We are aware of schools where RAN has been added to the early reading screening battery and, further, school professionals are considering assigning students to reading programs other than the school's core program based on those results. Neither our findings, nor those of previous investigators, support such a practice.

CONCLUSIONS

In this study we identified two variables that distinguished between students who were more or less responsive to Reading Recovery: PA and VSTM. Results also illustrate the challenges of accounting for all instances of early reading difficulties, even using a combination of theoretically linked reading, writing, and phonological processing measures.

Although PA and VSTM accurately forecasted responsiveness to Reading Recovery instruction for about two-thirds of the students in the sample, predictions were inaccurate for the remaining one-third. Because it is impossible to say for which children predictions would be right and for which they would be wrong, selection decisions for early intervention in reading cannot be based on predictions of which children will respond most robustly. In this respect, our results mirror those obtained by others who demonstrate the limitations of early screening efforts (e.g., Catts, Fey, Zhang, & Tomblin, 2001; Hammill, Mather, Allen, & Roberts, 2002; also see review by Jenkins & O'Connor, 2002). They also support the practicality of current Reading Recovery policy, which is to serve the lowest-achieving children first.

At the same time, although phonological processing did not account for the reduced rate of progress among all students in our sample, our results demonstrate that Reading Recovery serves a population in which phonological processing difficulties are apt to be prevalent. Because Reading Recovery does not provide a one-size-fits-all sequence of lessons, Reading Recovery teachers have the opportunity to craft an individually designed sequence of lessons, based on the unique and changing needs of each Reading Recovery student. Future research is needed to describe how Reading Recovery teachers adapt their teaching to enable students with initial phonological processing difficulties to make accelerative progress.

REFERENCES

Al Otaiba, S., & Fuchs, D. (2002). Characteristics of children who are unresponsive to early literacy intervention. *Remedial and Special Education, 27*, 300–316.

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: MIT Press.

Askew, B. J., Fountas, I. C., Lyons, C. A., Pinnell, G. S., & Schmitt, M. C. (1998). *Reading Recovery review: Understandings outcomes and implications.* Columbus, OH: Reading Recovery Council of North America.

Badian, N. (1998). A validation of the role of preschool phonological and orthographic skills in the prediction of reading. *Journal of Learning Disabilities, 31*, 472–481.

Bowers, P. G., & Wolf, M. (1993). Theoretical links among naming speed, precise timing mechanisms and orthographic skill in dyslexia. *Reading and Writing: An Interdisciplinary Journal, 5*, 69–85.

Catts, H. W., Fey, M. E., Zhang, X., & Tomblin, J. B. (2001). Estimating the risk of future reading difficulties in kindergarten children: A research-based model and its clinical implementation. *Language, Speech, and Hearing Services in Schools, 32*, 38–50.

Catts, H. W., Gillispie, M., Leonard, L. B., Kail, R. V., & Miller, C. A. (2002). The role of speed of processing, rapid naming, and phonological awareness in reading achievement. *Journal of Learning Disabilities, 35*, 509–534.

Center, Y., Wheldall, K., Freeman, L., Outhred, L., & McNaught, M. (1995). An experimental evaluation of Reading Recovery. *Reading Research Quarterly, 30*, 240–263.

Chapman, J. W., Tunmer, W. E., & Prochnow, J. E. (2001). Does success in Reading Recovery depend on developing proficiency in phonological-processing skills? A longitudinal study in a whole language instructional context. *Scientific Studies of Reading, 5*, 141–176.

Clay, M. M. (1993). *An observation survey of early literacy achievement.* Portsmouth, NH: Heinemann.

Clay, M. M., & Tuck, B. (1991). *A study of the Reading Recovery subgroups: Including outcomes for children who did not satisfy discontinuing criteria.* Auckland, New Zealand: University of Auckland.

Cornwall, A. (1992). The relationship of phonological awareness, rapid naming, and verbal memory to severe reading and spelling disability. *Journal of Learning Disabilities, 25*, 532–538.

Day, H. D., & Day, K. C. (1980). The reliability and validity of the Concepts about Print and Record of Oral Language. Resources in Education, EP179 932. Arlington, VA: ERIC Document Reproduction Service.

Fawcett, A. J., & Nicholson, R. I. (1994). Naming speed in children with dyslexia. *Journal of Learning Disabilities, 27*, 641–646.

Francis, D. J., Shaywitz, S. E., Stuebing, K. K., Shaywitz, B. A., & Fletcher, J. M. (1996). Developmental lag versus deficit models of reading disability: A longitudinal, individual growth curves analysis. *Journal of Educational Psychology, 88,* 3–17.

Gómez-Bellengé, F. X., Rodgers, E., & Fullerton, S. K. (2003). *Reading Recovery and Descubriendo la Lectura national report 2001–2002.* Columbus, OH: National Data Evaluation Center.

Hammill, D. D., Mather, N., Allen, E. A., & Roberts, R. (2002). Using semantics, grammar, phonology, and rapid naming tasks to predict word identification. *Journal of Learning Disabilities, 35,* 121–136.

Hatfield, P. (1994). *Performance characteristics of discontinued versus not discontinued children in the Reading Recovery program.* Unpublished dissertation. University of Maine, Orono.

Iversen, S. J., & Tunmer, W. E. (1993). Phonological processing skills and the Reading Recovery program. *Journal of Educational Psychology, 85,* 112–126.

Jenkins, J. R., & O'Connor, R. E. (2002). Early identification and intervention for young children with reading/learning disabilities. In R. Bradley, L. Danielson, & D. P. Hallahan (Eds.), *Identification of learning disabilities: research to practice* (pp. 99–149). Mahwah, NJ: Erlbaum.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology, 80,* 437–447.

Korhonen, T. T. (1995). The persistence of rapid naming problems in children with reading disabilities: A nine-year follow-up. *Journal of Learning Disabilities, 28,* 232–239.

Manis, F. R., Doi, L. M., & Bhadha, B. (2000). Naming speed, phonological awareness, and orthographic knowledge in second graders. *Journal of Learning Disabilities, 33,* 325–333, 374.

Meyer, M. S., Wood, F. B., Hart, L. A., & Felton, R. H. (1998a). Longitudinal course of rapid naming in disabled and nondisabled readers. *Annals of Dyslexia, 48,* 91–114.

Meyer, M. S., Wood, F. B., Hart, L. A., & Felton, R. H. (1998b). Selective predictive value of rapid automatized naming in poor readers. *Journal of Learning Disabilities, 31,* 106–117.

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

National Institute of Child Health and Human Development (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Report of the subgroups* (NIH Publication No. 00-4754). Washington, DC: U.S. Government Printing.

North America Trainers Group (2002). *What evidence says about Reading Recovery.* Columbus, OH: Reading Recovery Council of North America.

Pinnell, G. S., Lyons, C. A., DeFord, D. E., Bryk, A., & Seltzer, N. (1994). Comparing instructional models for the literacy education of high-risk first graders. *Reading Research Quarterly, 29,* 8–39.

Scarborough, H. S. (1998a). Early identification of children at risk for reading disabilities: Phonological awareness and some other promising predictors. In B. K. Shapiro, P. J. Accardo, & A. J. Capute (Eds.), *Specific reading disability: A view of the spectrum* (pp. 75–119). Timonium, MD: York Press.

Scarborough, H. S. (1998b). Predicting the future achievement of second graders with reading disabilities: Contributions of phonemic awareness, verbal memory, rapid naming, and IQ. *Annals of Dyslexia, 48,* 115–137.

Slavin, R. E., Karweit, N. L., & Madden, N. A. (1989). *Effective programs for students at risk.* Boston, MA: Allyn & Bacon.

Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Spector, J. E. (1992). Predicting progress in beginning reading: Dynamic assessment of phonemic awareness. *Journal of Educational Psychology, 84,* 353–363.

Stahl, K. A. D., Stahl, S., & McKenna, M. C. (1999). The development of phonological awareness and orthographic processing in Reading Recovery. *Literacy, Teaching, and Learning, 4,* 27–42.

Stanovich, K. E. (1992). Speculations on the causes and consequences of individual differences in early reading acquisition. In P. Gough, L. C. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 307–342). Hillsdale, NJ: Erlbaum.

Torgesen, J. K. (1977). Memorization processes in reading-disabled children. *Journal of Educational Psychology, 69,* 571–578.

Torgesen, J. K. (1996). A model of memory from an information processing perspective: The special case of phonological memory. In G. R. Lyon (Ed.), *Attention, memory, and executive function: Issues in conceptualization and measurement* (pp. 157–184). Baltimore, MD: Brookes.

Torgesen, J. K., & Houck, D. G. (1980). Processing deficiencies of learning-disabled children who perform poorly on the digit span test. *Journal of Educational Psychology, 72,* 141–160.

Torgesen, J. K., & Mathes, P. G. (2000). *A basic guide to understanding, assessing, and teaching phonological awareness.* Austin, TX: Pro-ed.

Torgesen, J. K., & Wagner, R. K. (1998). Alternative diagnostic approaches for specific developmental reading disabilities. *Learning Disabilities Research & Practice, 13,* 220–232.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities, 27,* 276–286.

Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Burgess, S., & Hecht, S. (1997). Contributions of phonological awareness and rapid automatic naming ability to the growth of word-reading skills in second- to fifth-grade children. *Scientific Studies of Reading, 1*, 161–185.

Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Rose, E., Lindamood, P., Conway, T. et al. (1999). Preventing reading failure in young children with phonological processing disabilities; group and individual response to instruction. *Journal of Educational Psychology, 91*, 1–15.

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

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

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

Whitehurst, G. J., & Lonigan, C. J. (2001). Emergent literacy: Development from prereaders to readers. In S. B. Neuman & D. K. Dickinson, *Handbook of Early Literacy Research* (pp. 11–29). New York: Guilford Press.

Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied Psycholinguistics, 14*, 1–33.

Wolf, M. (1991). Naming speed and reading: The contribution of the cognitive neurosciences. *Reading Research Quarterly, 26*, 123–141.

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.

Wolf, M., & Bowers, P. (1999). The "double-deficit" hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91*, 1–24.

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

Wolf, M., O'Rourke, A. G., Gidney, C., Lovett, M., Cirino, P., & Morris, R. (2002). The second deficit: An investigation of the independence of phonological and naming-speed deficits in developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal, 5*, 43–72.

Woodcock, R., & Johnson, M. B. (1989). *Woodcock-Johnson psychoeducational battery-revised: Tests of cognitive ability.* Chicago, IL: Riverside.

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

Yopp, H. (1995). A test for assessing phonemic awareness in young children. *The Reading Teacher, 49*, 20–29.