A Comparison of Two Reading Interventions for Children with Reading Disabilities

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Abstract

This study compared the effectiveness of two reading interventions in a public school setting. Forty-five second-grade children with reading disabilities were randomly assigned to a 6-week phonological awareness, word analogy, or math-training program. The two reading interventions differed from each other in (a) the unit of word analysis (phoneme versus onset-rime), (b) the approach to intervention (contextualized versus decontextualized), and (c) the primary domain of reading instruction (oral versus written language). Results indicate that children in both reading programs achieved significant gains in beginning reading skills, learning the specific skills taught in their respective programs, and applying what they had learned to uninstructed material on several transfer-of-learning measures, in comparison to children in the control group. For children in both reading intervention groups, the most significant mediator of growth in oral reading fluency was a child's initial level of word identification skill. Implications of these findings are that systematic, high quality reading intervention can occur in a small group, public school setting and that there are several different paths to the remediation of children with reading disabilities.

It is now widely accepted that the primary cause of reading disability for a majority of children lies in phonological processing inefficiencies that interfere with the development of phonological skills, such as phoneme segmentation, verbal memory, and name retrieval (e.g., Adams, 1990; Liberman, Shankweiler, & Liberman, 1989; Siegel, 1993; Stanovich, 1988; Torgesen, Wagner, & Rashotte, 1994; Vellutino, 1979; Wagner & Torgesen, 1987). Moreover, this has been shown to be true for children whose poor reading is discrepant from their IQ and for children whose poor reading is consistent with their IQ (e.g., Fletcher et al., 1994; Manis, Custodio, & Szeszulski, 1993; Stanovich & Siegel, 1994).

An understanding of the etiology of reading disability has enabled researchers to determine how inefficient phonological processing skills hinder the development of early literacy skills. For example, recent research has revealed that children at risk for reading failure, whether or not they have identifiable learning disabilities, have difficulty understanding and applying the "alphabet principle"—the concept that the sounds of speech map onto the letters of the alphabet (Adams, 1990; Lovett, Warren-Chaplin, Ransby, & Borden, 1990; Stanovich & Siegel, 1994; Wagner, Torgesen, & Rashotte, 1994). Knowledge of the alphabet principle, in turn, enables a child to develop word recognition, reading fluency, and reading comprehension skills. Moreover, children who master early reading skills find reading less time consuming and more enjoyable than poor readers (Chall, 1983; Stanovich, 1986). As a consequence, children who are better readers tend to read more, and through their experiences with written language, continue to improve their reading skills (Adams, 1990; Brown, Palinscar, & Purcell, 1986; Nagy, Anderson, & Herman, 1987). At the same time, children who are poor readers usually continue to fall behind in reading (Juel, 1988; Stanovich 1986), which negatively affects their academic achievement in other areas, as well as their self esteem and motivation to learn (Torgesen, 1977).

Beyond understanding the cause and consequences of reading disability, a growing body of treatment–outcome research has begun to shed light on how to effectively remediate the reading difficulties of children. Most of these studies have focused on word recognition because the acquisition of fluent, context-free word identification skills has been shown to be the major stumbling block for most elementary age children, and many older children, with reading disabilities (e.g., Stanovich, 1986, 1988; Vellutino, 1979, 1987). Results from this research indicate that phonologically-based approaches (e.g., Ball & Blachman, 1991; Foorman, Francis, Novy, & Liberman, 1991; Lovett, Borden, DeLuca, Lacerenza, Benson, & Brackstone, 1994) and whole word methods (e.g., Lalli & Shapiro, 1990; Lovett et al., 1990; O'Shea, Munson, & O'Shea, 1984) are both effective ways to improve the word recognition skills of children with reading disabilities (Swanson, O'Shaughnessy, McMahon, Hoskyn, & Sachse-Lee, 1998). However, these two approaches lead to important differences in transfer of learning.

In whole word instruction, children are taught to identify words as whole units rather than as a sequence of phonemes. That is, children's word recognition is based on word-specific learning. Conversely, in phonological skills training, children are taught how to analyze words by their letter–sound and letter cluster–sound subunits. In this case, children's word recognition is based on knowledge of the relationships among letters and letter clusters and their corresponding sounds. Thus, while whole word methods are effective in increasing a child's sight–word vocabulary, this approach alone does not provide a child with the kind of strategy-based learning he or she needs in order to analyze unfamiliar words (e.g., Carnine, 1977; Freebody & Bryne, 1988; Lovett et al., 1994; Vellutino & Scanlon, 1987). That is, children taught to recognize the words *bake* and *fish* by whole word methods, may not necessarily be able to read the words *snake* and *wish* without having previously learned strategies (e.g., how to decode at the level of phonemes (*c-a-t*) or onset-rime (*c-at*)) for doing so (Lovett, 1991; Lovett et al., 1994).

Instruction in phonologically-based reading strategies is a critical component of intervention for poor readers. However, most children with reading disabilities have tremendous difficulty acquiring these skills. For example, Lovett et al., (1990) trained the word recognition skills of children with severe reading disabilities using two different methods. One treatment group was taught by whole word methods, another treatment group was taught letter–sound correspondences, and a control group received study skills training. Children received 35 hours of intensive instruction in pairs. In this study, children with reading disabilities responded well to training by more than doubling the number of regular and exception words they could identify; however, both groups of children failed to generalize what they had learned to uninstructed reading vocabulary. Thus, even the children who received letter–sound training appeared to have acquired specific lexical knowledge rather than sublexical letter–sound knowledge, which could then be used to decode unfamiliar words.

In an effort to promote transfer of learning in children with reading disabilities, Lovett et al. (1994) compared two different methods of intensive word recognition training with severely disabled readers. Children with phonologically-based reading disabilities were randomly assigned to two word recognition training programs or to a study skills control program. Again, children received intensive instruction in pairs. One training program emphasized phonological awareness and subsyllable segmentation through direct instruction of phonological analysis, blending skills, and letter–sound correspondences (Phonological Analysis and Blending/Direct Instruction). The other program focused on teaching disabled readers a sight word vocabulary of frequent spelling patterns and how to use and monitor four decoding strategies (Word Identification Strategy Training). Results of this study provide strong evidence for the successful acquisition of alphabetic reading skills and transfer of learning in children with reading disabilities. However, the different intervention approaches led to different patterns of generalization. The phonological training program led to greater generalization in the phonological domain (i.e., nonsense word identification), and the strategy training program resulted in greater transfer of learning to real words (i.e., regular and exception word identification).

More recent studies of reading interventions for children with reading disabilities have also reported positive results. Vellutino et al. (1996) found that intensive instruction, 15 weeks of 30 minute daily one-on-one tutoring, focused on developing phonological awareness, a sight word vocabulary, and reading comprehension strategies successfully remediated most first-grade children with reading disabilities. Similarly, Torgesen, Wagner, Rashotte, Alexander, & Conway (1997) achieved significant gains with 10-year-old (on average) students with reading disabilities who received one-on-one tutoring in either explicit phonological awareness training plus direct instruction of synthetic phonics (i.e., phoneme) or implicit phonological awareness training plus phonics instruction embedded within reading and spelling activities. Although the studies referred to provide compelling evidence that the reading problems of many children are amenable to intervention under intensive one-on-one tutoring or instruction in pairs, it remains uncertain whether these findings would emerge in a public school setting, where interventions typically take place with larger groups of children.

The purpose of the present study was to evaluate the effectiveness of two reading intervention approaches in a public school setting with second-grade children identified with reading disabilities. In one approach, Phonological Awareness Training (PAT), the aim was to increase the phonological awareness of children through *direct instruction* of oral language activities and help children generalize their newly acquired skills to analyzing words in spelling and reading activities directed at the level of phonemes (i.e., cat = /k/-/a/-/t/). In the second approach, Word Analogy Training (WAT), the aim was to increase the phonological awareness of children through *contextualized* written language activities and help children transfer their newly acquired skills to analyzing words in spelling and reading activities directed at the level of *onsets and rimes* (i.e., cat = /k/-/at/). In sum, the goals of both reading interventions were to help children acquire a deeper awareness of the sounds of speech, an improved understanding of the connection between the sounds of speech and the letters of the alphabet (PAT) or the sounds of rimes and frequent spelling patterns (WAT), and an ability to analyze unfamiliar words. Although the two reading interventions differ in the size unit of word analysis (i.e., phoneme or onset-rime), the approach to intervention (i.e., contextualized or decontextualized), and the primary domain of reading instruction (i.e., oral or written language), these individual elements could not be separated from each other in the analyses. Rather, each reading intervention, as a whole, was compared to the other and to an alternative treatment control group that received mathematics training.

The present study addresses three critical issues in the reading intervention literature. First, since most reading intervention research has been conducted in highly controlled clinical settings, with instruction delivered one-on-one or in pairs, it is unclear whether the methods used in these studies can be generalized to public schools, with instruction delivered to larger groups of children. Thus, one aim of the present study was to evaluate the efficacy of small group, research-based reading intervention in the natural setting of public elementary schools. Second, it is still unclear which subsyllabic unit of word analysis, phoneme or onset-rime, is most effective in helping poor readers acquire and use alphabetic reading skills. That is, while some studies have reported significant gains after phoneme-based training (Alexander, Anderson, Heilman, Voeller, & Torgesen, 1991; Bradley & Bryant, 1985), others have found that a sizeable number of children with reading disabilities benefit only minimally from such training (Torgesen & Davis, 1996). It may be that some children respond better to remedial strategies that use larger phonological units that reduce the memory demands involved when children must sequentially blend together sounds to pronounce unfamiliar words (Goswami & Bryant, 1990; Snowling, 1996). Thus, a second aim of this investigation was to evaluate whether young children with inefficient phonological systems respond better to reading instruction that requires manipulation of the larger phonological units of onsets and rimes (i.e., WAT), rather than the smallest phonological units of individual phonemes (i.e., PAT) in spoken and written words. Finally, a persistent problem reported in many treatment–outcome studies is lack of, or limited, generalization after even intensive reading intervention (e.g., Lovett et al., 1990; Uhry & Shepherd, 1997; Vellutino & Scanlon, 1987). Thus, a third aim of the present study was to determine which reading intervention approach (i.e., PAT or WAT) was most effective in promoting transfer of learning to uninstructed reading material. Lovett et al. (1994) found that strategy-based training enhanced generalization to untrained regular and irregular words, although phonologically based training improved transfer to uninstructed regular words and phonological skills in comparison to the control condition. In the present study, we attempt to replicate these findings on transfer-of-learning measures related to regular words, phonological skills, and reading comprehension. In addition, based on Lovett et al. (1994), we predicted that children receiving WAT would be better able to generalize what they had learned to uninstructed reading material because they were trained to break apart words into larger chunks (onset-rime versus phoneme) that did not require as much phonological analysis or memory demand.

Method

Participants

The participants of this investigation initially consisted of all second-grade children referred to the first author by their teachers because of significantly below grade-level reading achievement. All children attended three elementary schools, with historically low achievement in reading, in a school district in southern California. The ethnic composition of the school district, during the year of the study (1997), was approximately 64.5% White, 28.7% Hispanic (predominately Mexican American), 3.9% African American, and 1.8% Asian. Each child referred was screened for inclusion in the study based on the following criteria: (1) At least average intelligence (i.e., Full scale IQ > 85) as measured by *Wechsler Intelligence Scale for Children–3rd Edition* (WISC-III): Information, Block Design, Vocabulary, and Digit Span subtests (Wechsler, 1991), (2) Scores below the 25th percentile on the *Woodcock Reading Mastery Tests–Revised* (WRMT-R): Word Identification, Word Attack, and Passage Comprehension subtests (Woodcock, 1987) and at least 1 year below grade level on *Curriculum-Based Measurement* (CBM; Deno, 1985) of oral reading fluency, and (3) Scores below the 25th percentile in phonological sensitivity as measured by the *Test of Phonological Awareness* (TOPA; Torgesen & Bryant, 1994b). Permission for children to participate in the study was obtained from the children's parents or legal guardians. Children with English as a second language and children whose histories included extreme hyperactivity, hearing impairment, brain damage, a chronic medical condition, or serious emotional disturbance were not included as participants. The *Conners Parent–Teacher Questionnaire* (Conners, 1990) was used to exclude children whose reading problems were associated with significant attention deficits.

The final sample included 45 children—21 girls and 24 boys—with reading disabilities. The ethnic composition of the final sample was 29 (64.4%) White, 13 (28.9%) Hispanic, 2 (4.4%) African American, and 1 (2.2%) Asian. At the time of pretesting, the participants had a mean age of 7 years, 8 months (SD = .38 years). The final sample had a mean Full Scale IQ of 89.9 (SD = 6.7), with the following mean subtest scores: Vocabulary 7.8 (SD = 1.9), Information 7.6 (SD = 2.1), Block Design 9.4 (2.1), and Digit Span 9.5 (2.3). Full scale IQ estimates were obtained by computing a Deviation Quotient from a short form of the *Wechsler Individual Scale for Children–Third Edition* (Wechsler, 1991) that included Information, Vocabulary, Block Design, and Digit Span subtests (Sattler, 1992).

The pretest screening battery confirmed the children's underachievement in oral and written language. On the WRMT-R, children achieved mean standard scores of 78.60 (SD = 8.45), 7th percentile on Word Identification; 81.00 (SD = 8.00), 10th percentile on Word Attack; and 77.18 (SD = 9.43), 6th percentile on Passage Comprehension subtests (Woodcock, 1987). On the *Peabody Individual Achievement Test-Revised* (PIAT-R), children earned a mean standard score of 78.36 (SD = 7.31), 7th percentile on the Spelling subtest (Markwardt, 1989). CBM (Deno, 1985) of oral reading fluency indicated that children were reading on average 17.22 (SD = 7.04) correct words per minute (CWPM) with an average accuracy of 62.90 (SD = 10.08) percent correct words on middle of first-grade-level reading passages. Thus, sample children were experiencing great difficulty reading first-grade level reading material (Deno & Mirkin, 1977). On the TOPA, children achieved a mean standard score of 77.51 (SD = 5.12), 7th percentile, placing them far below the vast majority of their same age peers.

TABLE 1
Characteristics of Intervention Groups at Pretesting

	Intervention Group					
	Math		PAT		WAT	
Characteristic	***M***	***SD***	***M***	***SD***	***M***	***SD***
Age in months	93.10	4.50	91.20	4.40	92.50	4.60
Cognitive ability						
Full scale IQ	**89.8**	**6.8**	92.5	8.5	87.4	2.6
Information	**7.5**	**2.4**	8.4	2.2	6.9	1.2
Vocabulary	**8.1**	**1.6**	8.3	1.8	7.1	2.1
Block design	**9.3**	**1.2**	9.8	2.6	9.0	2.1
Digit span	**9.3**	**2.2**	9.7	2.9	9.6	1.7
Academic achievement						
Phonological awareness	76.7	5.0	77.0	5.2	78.8	5.3
Word identification	**79.6**	**7.7**	77.6	7.2	78.6	10.6
Word attack	**81.6**	**7.8**	80.2	8.4	81.2	8.2
Passage comprehension	75.7	9.7	78.8	9.1	77.0	9.8
Spelling	79.4	7.1	78.5	5.5	77.2	9.2
Numerical operaions	**93.0**	**12.1**	93.2	8.2	89.1	11.0
Numerical reasoning	**87.0**	**7.3**	94.7	8.5	88.7	8.1
Oral reading fluency						
Correct words per minute	23.1	12.3	14.5	4.4	14.2	4.3
% Accuracy	67.5	15.5	60.3	8.1	61.0	6.4

Note. N = 15 for each intervention group. Intelligence was measured using the Wechsler Intelligence Scale for Children–Third Edition. Word Identification, Word Attack, and Passage Comprehension were measured using the Woodcock Reading Mastery Test–Revised. Spelling was measured using the Peabody Individual Achievement Test–Revised. Phonological Awareness was measured using the Test of Phonological Awareness. Oral reading rate and accuracy were measured using middle of first-grade reading passages from curricula used at participating schools. Numerical Operations and Numerical Reasoning were measured using the Wechsler Individual Achievement Test. *Source*: O'Shaughnessy (1997).

Children's mathematical skills were on average better than their oral and written language skills. On the *Wechsler Individual Achievement Test* (WIAT; Wechsler, 1992), children achieved a mean score of 91.76 (SD = 10.49), 30th percentile on Numerical Operations and a mean score of 90.13 (SD = 8.51), 25th percentile on Mathematical Reasoning. Table 1 shows the characteristics of the intervention groups at the time of pretesting.

With regard to socioeconomic status, two of the participating elementary schools had a sizable proportion—72.5% and 90.0%—of students who came from lower class families based on the number of students participating in the free or reduced lunch program and/or Chapter 1 services. The third elementary school had a smaller proportion—27%—of students who came from lower class families, with the majority of students coming from working class or middle class families.

Teacher Training

A paraprofessional at each participating elementary school was trained to teach *Phonological Awareness Training in Reading*, based on Torgesen & Bryant (1994a) and *Word Analogy Training* (WAT) based on Gaskins, Downer, and Gaskins (1986) and Lovett et al. (1994). One of the paraprofessionals was a high school graduate with four years experience assisting a resource special teacher who primarily taught students with mild learning disabilities. A second paraprofessional had completed some college coursework and had three years experience assisting a resource special teacher. The third paraprofessional was a junior in college, majoring in early childhood education and had worked as a teacher's aide in a regular education classroom for a year and a half providing one-on-one tutoring or small group instruction to at-risk students. Initial paraprofessional training took place two weeks before the start of the interventions. The first author trained the three paraprofessionals over 3 days for about 3 hours each session (10 hours total). In addition, systematic, ongoing supervision and training was provided each week during the interventions. During initial training, the paraprofessionals learned about current conceptions of reading development and effective reading instruction and worked through prepared phonological awareness, word analogy, and mathematics training program handbooks. Weekly supervision and ongoing training included review and discussion of the next week's lesson plans and objectives and involved a 1-hour weekly meeting.

Treatment Integrity

During the interventions, the first author visited each classroom weekly, completing a treatment integrity checklist each visit and recording the daily treatment integrity checklists that each paraprofessional kept. Treatment integrity was evaluated throughout the study by daily paraprofessional-completed treatment integrity checklists and weekly direct observation and investigator-completed treatment integrity checklists. In assessing treatment integrity, the occurrence or nonoccurrence of major treatment components was evaluated after each training session. The level of treatment integrity was obtained by calculating the percentage of treatment components implemented as designed over the 6 weeks of the study. Throughout interventions and across paraprofessionals, treatment integrity was very high with 97%–School A, 95%–School B, and 94%–School C fidelity of essential instructional practices.

Dependent Measures

For group design data analyses, five types of outcome measures were administered to all of the subjects before and after 9 hours of training. Pre- and posttesting included measures of trained content, transfer of learning, experimental measures of phonological working memory, behavioral correlates, and mathematics. For single-subject design data analyses, baseline and weekly curriculum-based oral reading fluency data were collected and graphed.

Group Design

Trained Content Measures. Trained content was measured by word reading accuracy of the 102 words covered in PAT and the 90 words covered in WAT. The words included in both PAT and WAT reading programs came from a list of the 2,500 words most frequently appearing in the oral language of children in the first grade (Stemach & Williams, 1988), and included monosyllabic words with high frequency spelling patterns such as *pan, bat,* and *dig* (PAT) and *dog, cat,* and *bus* (WAT). Thus, the trained words in each reading program were very similar, but with less than 10% overlap between programs. In addition, the TOPA was individually administered to each child to assess awareness of the individual sounds in words. On this test, children were asked to identify the ending sounds in words. In the first subtest, which included 10 items, children were required to identify which of three words ended in the same sound as a stimulus word. In the second subtest, which also included 10 items, children were required to identify which of four words ended in a different sound from the others. The task demands of the TOPA were similar to some of the oral language activities included in the two reading interventions. That is, some activities in the two reading programs also required children to focus attention on the final sounds in series of words and determine whether they were similar or different. However, each reading program and, in particular PAT, extended beyond this level of phonological awareness. There is 14% and 6% overlap between the words used in the TOPA and the words in the PAT and WAT reading intervention programs, respectively. The scoring for this test is based on national norms and includes standard scores and percentiles. The reported internal consistency reliability for the TOPA was .89. And finally, an experimental measure of phonemic deletion was administered (Stanovich, Cunningham, & Cramer, 1984). On this task, children were asked to take away the first sound in a word (e.g., *cat*) and say what new word was left afterward (e.g., *at*). After several practice words, there were nine words that made up this task (i.e., pink, man, nice, win, bus, pitch, car, hit, and pout).

Transfer-of-Learning Measures. The second set of measures focused on transfer-of-learning effects. The *Woodcock Reading Mastery Test–Revised* Word Identification, Word Attack, and Passage Comprehension subtests were administered. Word Identification assesses transfer of learning to an untrained list of words, and Word Attack assesses phonological decoding of nonwords like *ift, troov,* and *zim.* Nonword reading tests can provide an important measure of change in letter–sound knowledge and has the potential to assess phonological processes in reading separate from specific reading vocabulary (Rack, Snowling, & Olson, 1992). Passage Comprehension utilizes a cloze procedure in which the child silently reads a passage and then provides a word that belongs in a blank, with a variety of responses scored as correct. The WRMT-R is nationally normed and provides standard scores, percentiles, and age equivalents. The reported internal consistency reliability coefficients (split-half procedure, third grade) were .97, .91, and .92 for Word Identification, Word Attack, and Passage Comprehension, respectively. Transfer of learning to a second standardized measure of academic achievement was assessed using the *Peabody Individual Achievement Test–Revised* (PIAT; Markwardt, 1989) Spelling subtest. The PIAT-R spelling subtest was included as an outcome measure because of the strong association between early spelling skills, phonological awareness, and beginning reading skills (Ehri & Wilce, 1987). In addition, this provided a measure of orthographic processing skills. Currently, there are diverging findings about whether or not orthographic coding skill contributes to the word recognition difficulties of poor readers (e.g., Olson, Wise, Conners, Rack, & Fulker, 1989). In the four-choice Spelling subtest, a child demonstrates the ability to recognize standard spellings by choosing the correct spelling of a word spoken by the examiner. This subtest was selected in order to assess changes in orthographic processing skills. The PIAT-R is nationally normed and provides standard scores, percentiles, and age- and grade-equivalents. Split-half reliability coefficients for the Spelling subtest (second grade) is .95.

Experimental Measures. In order to assess the influence of reading interventions on phonological working memory (i.e., converting words into sound representations), two experimental measures were administered. The first, Rhyming Words, assesses a child's recall of similar-sounding words (Swanson, 1992, 1996). In this task, the child listens to sets of words that rhyme. The seven word sets range from 2 to 10 monosyllabic words. Before children recall the words, they are asked whether a particular word was included in the set. For example, the child is presented the words *lip-slip-clip* and then asked if *ship* or *lip* was in the word set. The child is then asked to recall the previously presented words (*lip-slip-clip*). The dependent variable is the number of rhyming word sets recalled correctly (range 0–7). The second, Sentence Span, assesses a child's auditory recall of each word at the end of a set of unrelated declarative sentences 7 to 10 words in length (Swanson, 1992). After the examiner orally presents a set of sentences, the child is asked a comprehension question about one of the sentences. The dependent variable on this task is the number of sentence-ending words recalled correctly in order (range 0–4; Daneman & Carpenter, 1980). Cronbach's coefficient alpha for this measure is .92.

Behavioral Correlates. In order to assess the impact of training on the behaviors of children that may affect teacher–student relations, peer acceptance, and academic performance, the *Social Skills Rating System* (SSRS; Gresham & Elliott, 1990) was administered. The SSRS uses a teacher rating scale to sample teacher's perceptions of children's academic competence, problem behaviors, and social skills. The SSRS teacher form shows acceptable levels of internal consistency and test–retest reliability. Internal consistency estimates are .94 for the Total Social Skills Scale, .87 for the Total Problem Behavior Scale, and .95 for the Academic Competence Scale.

Mathematics. To assess growth in mathematics by the Math-trained control group children, Numerical Operations and Mathematical Reasoning subtests of the WIAT. Numerical Operations assesses a child's ability to write dictated numerals and solve calculation problems and equations involving all basic math operations (i.e., addition, subtraction, multiplication, and division). Mathematical Reasoning assesses a child's ability to reason mathematically. The WIAT is nationally normed and provides standard scores, percentiles, and age- and grade-equivalents. Reported age-based reliability coefficients were .90 and .85 for Mathematical Reasoning and Numerical Operations (7 years of age), respectively.

Single-Subject Design

CBM (Shinn, 1989) of oral reading fluency was administered to measure transfer of learning to children's actual reading curriculum. Curriculum-based reading materials were used to assess baseline and treatment levels of oral reading speed and accuracy with each child prior to and during the interventions. Once stable baseline levels were established, oral reading was monitored weekly to assess student growth. To assess the effects of treatment, 40 excerpts from 75–100 words in length were selected from passages in two literature-based language arts basal readers used by the school district. These first-grade reading level books were selected because they were used by participating schools as supplemental readers. Thus, the vast majority of passages were new to the students.

Middle of first grade–level reading passages was used for assessment throughout the study because none of the sample children had achieved mastery at this level. And while this ensured that the level of difficulty of the passages remained fairly consistent throughout the study, some children were reading passages at a level that was too difficult for them. In CBM, instructional level is a reading level at which text has not yet been completely mastered but also is not too difficult. For second-grade children, Frustration Level is 29 or fewer correct words per minute, Instructional Level is 30–49 words correct per minute, and Mastery level is 50+ words correct per minute (Deno & Mirkin, 1977). One minute oral reading probes were drawn randomly from the pool of passages and consisted of the child reading a one minute timed passage.

Two measures were used to assess the effects of the intervention on oral reading performance: (1) Speed or the number of words read correctly per minute and (2) Accuracy or the percentage of words read correctly with substitutions, omissions, mispronunciations, and hesitations of 3 seconds or more scored as errors (Shinn, 1989).

Interobserver Agreement. A second independent observer scored the responses of 50% of the audiotaped sessions using photocopies of the reading passages. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Interobserver agreement for correct words per minute and accuracy was 98% and 94%, respectively.

Individual Growth Estimates

Individual measurements of oral reading fluency during each week of training were also analyzed using individual growth-curve methodology (e.g., Bryk & Raudenbush, 1987). The analyses involved in this approach consisted of determining the mean rate of change for each of the two reading intervention groups (i.e., PAT and WAT) and then estimating the extent to which individual children differ from this mean rate. Finally, correlates of change were determined using pretest variables as predictors of growth rate in oral reading fluency. Individual estimates of change in correct words per minute and accuracy across 6 waves of data (i.e., oral reading fluency measured weekly over 6 weeks of intervention), and reading intervention group intercepts and slopes were estimated using SAS Proc Mixed (SAS Institute, 1995).

Overview of Intervention Procedures

The two experimental reading intervention programs consisted of intensive PAT or WAT. Table 2 contrasts the two reading interventions in terms of organizational unit, approach to instruction, instructional unit, emphasis of instruction, and activities. Interventions were implemented 30 minutes a day, three times a week, for six weeks when the children were in the middle of second grade. The goals of the interventions were to help children acquire a deeper awareness of the sounds of speech, an improved understanding of the connection between the sounds of speech and the letters of the alphabet (PAT) or the sounds of rimes and frequent spelling patterns (WAT), and an increased ability to analyze words. More specifically, PAT consists of systematic, direct instruction of sound blending, sound segmenting, and a small set of letter-sound correspondences (based on Torgesen & Bryant, 1994a; Torgesen, Morgan, & Davis, 1992) whereas WAT consists of systematic, contextualized instruction in rhyming and the compare/contrast decoding strategy for children to use to identify unfamiliar words (based on Gaskins, Downer, & Gaskins, 1986; Lovett et al., 1994). Thus, the two interventions represent different approaches to reading instruction. In PAT, instruction and practice are decontextualized whereas in WAT, instruction and practice are embedded within the context of reading and spelling activities. The two intervention approaches also teach word analysis skills using different sized units—in PAT the smallest units of letter–sound mapping, and in WAT the larger units of onset-rime and whole word. And finally, in PAT the majority of instruction emphasizes oral language skills, but in WAT the majority of instruction focuses on written language skills. Both reading interventions were supplemental to regular classroom reading instruction.

Phonological Awareness Training (PAT). The PAT (O'Shaughnessy, 1997) program was based on Phonological Awareness Training for Reading. This reading intervention was designed to enhance children's awareness of the sound structure of words. In particular, it helps children understand how spoken language is represented by the alphabet system of written language. PAT is divided into four sets of activities: rhyming, sound blending, sound segmenting, and reading and spelling activities. At first, children engage in rhyming activities to focus their attention on the sounds in words. After these activities, children learn how to blend individual sounds into words. Children are taught to blend all the individual sounds in a word (e.g., *d-o-g*) to say the word (*dog*). Blending skills are taught prior to segmenting skills because blending has been found to be easier for children to learn.

When children are first introduced to segmenting, they identify words that have the same beginning sound. Then, after children have practiced blending and simple segmenting, they are introduced to activities that involve more complete word analysis. As children

TABLE 2
Characteristics of Two Reading Interventions

Characteristic	Phonological Awareness Training	Word Analogy Training
Organizational unit	group of five children	group of five children
Approach to instruction	isolated skill instruction	contextualized skill instruction
Instructional unit	phonemes	whole words & onset-rime
Emphasis of instruction	oral language skills	written language skills
Activities	rhyming rhyming extensions sound blending sound isolation sound segmentation review manipulate small set of letters spelling & reading activities games	rhyming rhyming extensions whole word identification manipulate onsite-rime spelling review practice compare/contrast strategy extensions of word analogy strategy games

learn segmenting skills, they keep practicing blending skills. In the segmenting activities, children identify words that have the same beginning, ending, or middle sounds. Children are also taught to indicate which position in a word a given sound occupies and to pronounce individual sounds that occur at the beginning and ending of words.

In the final stage of training, children use letters to represent the sounds in words. These activities show the children how to use their phonological awareness skills in reading and spelling because letters are used to represent the individual sounds in words. These activities help children transfer their newly acquired phonological awareness and knowledge of letter-sounds to reading and spelling activities.

Word Analogy Training (WAT). The WAT program trains children in the acquisition, use, and monitoring of a strategy to use to decode unknown words. A large part of the WAT program was based on a decoding program developed at the Benchmark School in Pennsylvania. The primary strategy that was taught and practiced was word identification by analogy or the compare and contrast strategy.

Successful use of the compare and contrast strategy depends on knowledge of a set of 90 key words with high-frequency spelling patterns. The key words are taught using a whole word approach (5 new key words were taught per session), and once a key word was introduced, it was displayed on a wall chart organized by vowel sound and rime patterns. Knowledge of the key words represents a basic knowledge of frequent spelling–sound patterns and is the basis for successful application of the compare and contrast strategy.

The first part of each lesson involves introduction of five new key words and review of all known key words. The remainder of the lesson is devoted to explicit, but contextualized (i.e., words to be decoded are in sentences), strategy training and practice. Teachers model using the compare/contrast strategy, explain how it can be applied, and describe how to check to see if the strategy is working. The compare and contrast strategy is practiced systematically, and instructional words are selected, from the key word set, to be good exemplars for applying the strategy. In word identification by analogy, children are taught to compare an unfamiliar word to an already known word (i.e., from the key word set) to help them decode the new word. For example, if a child knows the words *flag* and *let*, they can decode the word *magnet*. Rhyming and abstraction of rime patterns provide the basis for word identification by analogy and are central to successful word recognition in the WAT program. Thus, another key element of the WAT program is extensive practice recognizing and generating rhyming words to help children further develop their phonological awareness. More specifically, PAT consists of systematic, direct instruction of sound blending, sound segmenting, and a small set of letter–sound correspondences (based on Torgesen & Bryant, 1994a; Torgesen, Morgan, & Davis, 1992) whereas WAT consists of systematic, contextualized instruction in rhyming and the compare/contrast decoding strategy for children to use to identify unfamiliar words.

The two experimental groups were compared to each other and to an alternative treatment control group, which received a mathematics program. Control subjects received the same amount of instructional time, as did children in the two experimental reading programs; however, instead of reading instruction, the control group received mathematics training. Through discussion and planned activities, the mathematics training program worked at helping children acquire better math computation and problem-solving skills in the areas of time, money, and subtraction with regrouping. The math training lessons follow a three-step learning sequence: warm-up, instruction, and wrap-up and involved both direct instruction and activities to promote experiential learning of math content and strategies. Base ten blocks were used to teach the computational operation of subtraction with regrouping.

In terms of experimental design, the inclusion of a control group is important because it ensures that any treatment effects obtained for either PAT or WAT training programs may be attributed to the specific content of training rather than to participation in a small group intervention program. Children in the control group were provided with PAT after all posttesting was completed.

Children at each elementary school were randomly assigned to a treatment condition. The children were taught in groups of 5 in quiet classrooms at each of the participating elementary schools. The programs were administered by a trained paraprofessional, with each paraprofessional implementing each program at his or her site and the order of interventions varied at each site. There was no attempt to control for other educational experiences of the children. During the study, children did not receive any other remedial reading assistance outside of their general education instruction, and teachers, parents, and administrators did not know which children were assigned to which particular treatment group.

Based on teacher interviews, the three participating elementary schools provided different beginning reading instruction. Most teachers at one elementary school reported using an eclectic approach, with the actual emphasis of instruction depending on a teacher's training in reading and personal philosophy of teaching. The majority of teachers at a second school reported following a whole language, discovery approach to language arts instruction; however, some teachers believed that children at risk for reading problems needed explicit instruction in letter–sound correspondences and provided such instruction. And finally, a third elementary school was a magnet school for back-to-basics instruction; hence, every teacher was trained in explicit, systematic phonics instruction.

Results

Preliminary Comparisons

Preliminary comparisons revealed that the treatment groups did not differ significantly in proportions of female and male participants, $\chi^2(2, N = 45) = .54$, $p > .05$. In addition, treatment groups did not differ significantly in IQ, $F(2, 42) = 2.40$, $p > .05$ or AGE, $F(2, 42) = .67$, $p > .05$. Similarly, the three participating elementary schools did not differ significantly from each other in gender, IQ, or AGE ($ps > .05$). And finally, treatment groups and schools did not differ significantly in proportions of participants in two ethnic categories (i.e., White and Hispanic ethnic categories only due to the small number of African American ($n = 2$) and Asian ($n = 1$) students in the study) $\chi^2(2, N = 45) = .08$, $p > .05$ and $\chi^2(2, N = 42) = 1.00$, $p > .05$, respectively.

Group Design Data Analyses. As shown in Table 3, pre- and posttesting included measures of trained content, transfer of learning, experimental measures of phonological working memory, behavioral correlates, and mathematics. Dependent measures that purport to assess the same or related skills were analyzed together via a 3 (Treatment: PAT, WAT, Math) × 2 (Time: pretest, posttest) multivariate analysis of variance (MANOVA), with repeated measures on the second factor. Each MANOVA determines whether a significant difference exists among the three treatment groups when compared on all of the dependent measures at pre- and posttesting simultaneously. Thus, the primary effect of interest in each MANOVA was the treatment by time interaction.

When a significant treatment by time interaction was revealed in the multivariate analysis, univariate analyses of covariance (ANCOVAs) were con-

TABLE 3
Pretest and Posttest Raw Scores

	Math group					PAT group					WAT group				
	Pretest		Posttest		Diff	Pretest		Posttest		Diff	Pretest		Posttest		Diff
Measures	*M*	*SD*	*M*	*SD*	*M*	*M*	*SD*	*M*	*SD*	*M*	*M*	*SD*	*M*	*SD*	*M*
Trained content															
PAT Word List (/102)	15.1	8.3	19.2	8.1	4.1	8.7	6.1	37.1	14.2	28.4	12.9	11.4	38.2	18.7	25.3
WAT Word List (/90)	20.0	11.2	25.5	12.6	5.5	16.1	7.5	37.5	9.8	21.4	18.2	12.2	50.9	14.9	32.7
TOPA (/20)	9.6	2.6	10.8	3.4	1.2	9.6	2.8	17.1	2.7	7.5	10.6	2.9	14.9	3.5	4.3
Phonemic Deletion (/9)	3.9	2.2	4.7	2.2	0.8	3.4	2.0	8.4	1.1	5.0	3.8	1.5	7.8	1.8	4.0
Transfer of learning															
WRMT-R Word Identification (/106)	20.7	9.5	24.3	9.6	3.6	15.5	8.1	20.9	9.6	5.4	18.4	7.7	23.1	6.5	4.7
WRMT-R Word Attack (/45)	5.1	3.9	6.3	5.5	1.2	3.5	2.2	8.2	3.4	4.7	4.3	2.0	8.3	3.4	4.0
WRMT-R Passage Comprehension (/68)	8.5	4.7	11.8	6.1	3.3	7.9	4.7	14.2	7.2	6.3	8.1	4.0	15.2	4.3	7.1
PIAT-R Spelling (/100)	26.4	5.9	27.3	6.1	0.9	23.7	4.6	29.6	4.8	5.9	24.4	6.6	31.1	5.6	6.7
Phonological working memory															
Rhyming Words (/7)	0.7	0.9	1.1	1.1	0.4	1.0	1.1	2.3	0.9	1.3	0.8	0.7	20.0	0.4	1.2
Sentence Span (/4)	0.2	0.4	0.3	0.6	0.1	0.3	0.6	1.4	0.9	1.1	0.1	0.3	0.9	0.8	0.8
Behavioral correlates															
SSRS-Academic Competence (/45)	22.9	6.0	23.7	5.8	0.8	22.1	5.2	25.9	6.0	3.8	22.8	3.8	25.7	5.1	2.9
SSRS-Problem Behaviors (/36)	11.3	9.2	10.8	8.2	–0.5	8.9	5.1	8.4	4.2	–0.5	7.2	5.7	7.6	5.0	0.4
SSRS-Social Skills (/60)	36.7	12.4	37.4	12.0	0.7	38.9	7.9	39.7	8.4	0.8	40.6	11.0	40.5	10.4	–0.1
Mathematics															
WIAT Numerical Operations (/40)	11.7	3.8	14.1	3.0	2.4	10.9	2.3	12.1	2.2	1.2	10.5	2.6	11.6	2.6	1.1
WIAT Mathematics Reasoning (/50)	13.3	4.5	18.3	3.9	5.0	15.7	4.3	17.5	4.5	1.8	13.9	3.6	16.3	4.0	2.4

Note. PAT = phonological awareness training; WAT = word analogy training; TOPA = Test of Phonological Awareness; WRMT-R = Woodcock Reading Mastery Test–Revised; PIAT-R = Peabody Individual Achievement Test–Revised; SSRS = Social Skills Rating System; WIAT = Wechsler Individual Achievement Test.

ducted, with treatment group again the between subjects factor, posttest scores the dependent variable, and pretest scores the covariate. All significant effects revealed in ANCOVA were then further analyzed using Tukey-Kramer HSD post-hoc multiple comparisons. The Tukey-Kramer HSD test compares all pairs of adjusted means (i.e., least square means) using a family-wise alpha level. In addition, effect sizes were calculated from means and standard deviations of raw scores (i.e., using Hedges' [1987] effect size calculation: $ES = \bar{X}_{trt} - \bar{X}_{ctrl}/sd_{pooled}$ when ANCOVA yielded a significant difference among the three groups at posttest. For interpretation, Cohen's 1988 scale of the magnitude of effect size was used, with an effect size of .2 small, .5 medium, and .8 large.

Raw score and standard score pre- and posttesting means and standard deviations for each treatment group are reported in Table 3 and Table 4, respectively. Table 5 shows the results from the ANCOVA on posttest scores with pretest scores as covariate and Tukey-Kramer HSD multiple comparisons.

It should be noted that preliminary analyses with school in the model as a second between subjects variable yielded no significant main effects or school × treatment and time × school interactions across all dependent measures (*ps* > .05). Similarly, preliminary analyses with gender in the model as a second between subjects variable yielded no significant main effects or interactions across all dependent measures (*ps* > .05). And finally, no significant main effects or interactions emerged between White and Hispanic ethnic categories (i.e., White and Hispanic ethnic categories only due to the small number of African American [*n* = 2] and Asian [*n* = 1] students in the study) across of dependent measures, *ps* > .05). Thus, school, gender, and ethnicity were not considered further in the analyses.

Trained Content. Significant main effects emerged for treatment $F(2, 42) = 4.48$, $p < .05$ and time $F(7, 36) = 183.74$, $p < .0001$, as well as the interaction between treatment × time $F(14, 72) = 18.37$, $p < .0001$, in the MANOVA for TOPA, Phonemic Deletion and PAT and WAT word lists. Follow-up ANCOVA revealed significant posttest group effects on all four trained content measures (*ps* < .0001), and Tukey comparisons indicated that both PAT-trained and WAT-trained groups outperformed the Math-trained control group on these measures. On the standardized measure of phonological sensitivity (i.e., TOPA), the PAT-trained group was significantly superior at posttest to the WAT-trained children ($p < .001$), revealing that, as a group, the PAT-trained children acquired higher levels of phonological awareness (which was the primary emphasis of the program) than the WAT-trained children. However, children in both remedial programs acquired increased phonologi-

TABLE 4
Pretest and Posttest Standard Scores

	Math group					PAT group					WAT group				
	Pretest		Posttest		Diff	Pretest		Posttest		Diff	Pretest		Posttest		Diff
Measures	*M*	*SD*	*M*	*SD*	*M*	*M*	*SD*	*M*	*SD*	*M*	*M*	*SD*	*M*	*SD*	*M*
Trained content															
TOPA	76.7	5.0	79.6	6.3	2.9	77.0	5.2	97.5	11.2	20.5	78.8	5.3	88.8	8.2	10.0
Transfer of learning															
WRMT-R Word Identification	79.6	7.7	79.4	7.2	–0.2	77.6	7.2	79.5	8.6	1.9	78.6	10.6	79.2	8.3	0.6
WRMT-R Word Attack	81.6	7.8	80.8	8.6	–0.8	80.2	8.4	87.0	6.1	6.8	81.2	8.2	85.6	6.4	4.4
WRMT-R Passage Comprehension	75.7	9.7	78.6	8.9	2.9	78.8	9.1	85.1	10.0	6.3	77.0	9.8	85.1	7.7	8.1
PIAT-R Spelling	79.4	7.1	79.8	6.7	0.4	78.5	5.5	84.9	8.4	6.4	77.2	9.2	84.9	9.6	7.7
Behavioral correlates															
SSRS-Academic Competence	84.7	8.6	85.7	8.1	1.0	83.4	6.7	90.6	13.0	7.2	83.5	5.0	90.2	9.8	6.7
SSRS-Problem Behaviors	104.9	17.9	103.8	15.8	–1.1	100.8	11.1	99.8	9.9	–1.0	97.1	12.6	98.9	11.5	1.8
SSRS-Social Skills	94.0	16.2	94.8	15.0	0.8	96.3	9.5	98.3	10.3	2.0	98.0	13.9	97.5	12.7	–0.5
Mathematics															
WIAT Numerical Operations	93.0	12.1	101.1	10.7	8.1	93.2	8.2	95.3	6.3	2.1	89.1	11.0	91.9	10.9	2.8
WIAT Mathematics Reasoning	87.0	7.3	97.3	8.7	10.3	94.7	8.5	97.1	8.5	2.4	88.7	8.1	92.1	9.0	3.4

Note. Each standardized measure is based on a mean of 100 and a standard deviation of 15. PAT = phonological awareness training; WAT = word analogy training; TOPA = Test of Phonological Awareness; WRMT-R = Woodcock Reading Mastery Test–Revised; PIAT-R = Peabody Individual Achievement Test–Revised; SSRS = Social Skills Rating System; WIAT = Wechsler Individual Achievement Test.

cal awareness, with the PAT-trained children improving from a standard score of 77.00 (SD = 5.22) at pretesting to a standard score of 97.50 (SD = 11.20) at posttesting and the WAT-trained children increasing from a standard score of 78.80 (SD = 5.31) at pretesting to a standard score of 88.79 (SD = 8.20) at posttesting.

On the PAT word list, the two treatment groups were equally successful in reading significantly more words (i.e., real words with regular spelling patterns) after treatment. Thus, the PAT group successfully learned the specific content of their reading lessons, and the WAT group successfully transferred what they had learned from their lessons to reading uninstructed words from the PAT program. On the WAT word list, the WAT-trained group was significantly superior at posttest to PAT children ($p < .01$), indicating that the WAT group successfully learned the specific content of their reading program. In addition, the PAT-trained children read significantly more WAT words after training than the Math-trained children (PAT > Math, $p < .001$) indicating generalization of learning.

Large effect sizes (ES) were obtained on all four trained content measures: TOPA: ES = 2.07 (PAT > Math), ES = 1.17 (WAT > Math), ES = 0.75 (PAT > WAT); Phonemic Deletion: ES = 2.23 (PAT > Math), ES = 1.56 (WAT > Math), ES = .41 (PAT > WAT); PAT Word List: ES = 1.61 (PAT > Math), ES = 1.42 (WAT > Math), ES = .07 (WAT ≈ PAT); and WAT Word List: ES = 1.07 (PAT > Math), ES = 1.85 (WAT > Math), ES = 1.09 (WAT > PAT).

In summary, PAT- and WAT-trained children demonstrated sizable intervention gains in acquisition of specifically trained content and in generalization of word identification skills to uninstructed word lists with regular spelling patterns. The advantage of PAT training in comparison to the other conditions was on the TOPA. The advantage of WAT training when compared to the other conditions was on the WAT word list. Both PAT and WAT interventions yielded statistically comparable effects on the PAT word list and the Phonemic Deletion task.

Transfer of Learning. Significant main effects emerged for treatment $F(2, 42) = 3.36$, $p < .05$, and time $F(7, 36) = 180.89$, $p < .0001$, as well as the interaction between treatment × time $F(14, 72) = 2.10$, $p < .05$, in the MANOVA for WRMT-R Word Identification, Word Attack, and Passage Comprehension subtests and the PIAT-R Spelling subtest. Follow-up ANCOVA revealed significant group differences on the Word Attack subtest ($p < .01$). A post hoc analysis indicated that both the PAT-trained ($p < .01$) and WAT-trained ($p < .05$) children outperformed the Math-trained children on this outcome measure. As shown in Table 5, the WAT-trained group displayed significant improvement in Passage Comprehension and Spelling, when compared to the Math-trained group ($p < .05$). No significant differences ($ps > .05$) emerged between the PAT- and WAT-trained groups or between PAT-trained and Math-trained groups on these measures. No significant differences ($ps > .05$) between treatment groups were found on the Word Identification subtest.

The effect sizes for Word Attack, Passage Comprehension, and Spelling transfer-of-learning measures were of small and medium magnitudes: Word Attack: ES = .45 (PAT > Math), ES = .47 (WAT > Math), ES = .01 (PAT ≈ WAT); Passage Comprehension: ES = .36 (PAT > Math), ES = .65 (WAT > Math), ES = .18 (WAT > PAT); Spelling: ES = .42 (PAT > Math), ES = .65 (WAT > Math), ES = .29 (WAT > PAT).

In summary, both PAT- and WAT-trained children displayed significantly improved word attack skills after training, in comparison to Math-trained children. WAT training yielded significant gains in passage comprehension and spelling in comparison to

TABLE 5
Results from One-Way Analyses of Covariance on Posttest Scores with Pretest Scores as Covariate: Univariate *F*-values

	df	Treatment	Treatment comparisons
Trained content			
PAT Word List	2, 41	40.43****	PAT & WAT > Math***
WAT Word List	2, 41	95.36****	WAT > PAT > Math**
TOPA	2, 41	18.49****	PAT > WAT > Math****
Phonemic Deletion	2, 41	28.93****	PAT & WAT > Math****
Transfer of learning			
WRMT-R Word Identification	2, 41	0.69	n.a.
WRMT-R Word Attack	2, 41	6.25**	PAT & WAT > Math**
WRMT-R Passage Comprehension	2, 41	3.58*	WAT > Math*
PIAT-R Spelling	2, 41	6.41**	WAT > Math*
Phonological working memory			
Rhyming Words	2, 41	9.13***	PAT & WAT > Math****
Sentence Span	2, 41	4.38*	PAT & WAT > Math****
Behavioral correlates			
SSRS-Academic Competence	2, 41	2.97	n.a.
SSRS-Problem Behaviors	2, 41	0.23	n.a.
SSRS-Social Skills	2, 41	0.17	n.a.
Mathematics			
WIAT Numerical Operations	2, 41	3.40*	Math > PAT & WAT**
WIAT Mathematics Reasoning	2, 41	3.97*	*n.s.*

Note. PAT = phonological awareness training; WAT = word analogy training; TOPA = Test of Phonological Awareness; WRMT-R = Woodcock Reading Mastery Test–Revised; PIAT-R = Peabody Individual Achievement Test–Revised; SSRS = Social Skills Rating System; WIAT = Wechsler Individual Achievement Test.
*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$.

Math training; however, no significant differences emerged between PAT-trained and WAT-trained groups or between PAT-trained and Math-trained groups on these measures.

Phonological Working Memory. Significant main effects emerged for treatment $F(2, 42) = 3.98$, $p < .05$, and time $F(3, 40) = 54.91$, $p < .0001$, as well as the interaction between treatment × time $F(6, 80) = 2.83$, $p < .05$, in the MANOVA for the two experimental measures of phonological working memory, Rhyming Words and Sentence Span. Subsequent univariate analyses of covariance (ANCOVA) revealed significant group effects (*ps* < .05). Post hoc multiple comparisons indicated that both PAT- and WAT-trained groups outperformed the Math-trained control group on both phonological working memory measures (*ps* < .0001).

Effect sizes for Rhyming Words were large in comparisons between reading treatment groups and the control group: *ES* = 1.18 (PAT > Math), *ES* = 1.21 (WAT > Math), and moderate between reading treatment groups *ES* = .43 (PAT > WAT). The magnitude of effect sizes for Sentence Span were large between PAT-trained and Math-trained children *ES* = .98 (PAT > Math), moderate between WAT-trained children and the Math-trained control group *ES* = .66 (WAT > Math), and small between reading treatment groups *ES* = .32 (PAT > WAT).

In summary, both PAT- and WAT-trained children demonstrated significant gains in phonological working memory after intervention, in comparison to Math-trained control children.

Behavioral Correlates. Although a significant main effect emerged for time $F(5, 38) = 36.46$, $p < .0001$, no significant main effect was observed for treatment $F(2, 42) = .023$, $p > .05$, or the interaction between treatment × time $F(10, 76) = .86$, $p > .05$, in the MANOVA for SSRS derived behavioral correlates. No further analyses were conducted on these data.

Mathematics. Although no significant main effect emerged for treatment $F(2, 42) = .77$, $p > .05$, a significant main effect was observed for time $F(2.41, 101.21) = 62.69$, $p < .0001$, as well as the interaction between treatment × time $F(4.82, 101.21) = 2.84$, $p < .05$, in the MANOVA for Numerical Operations and Mathematical Reasoning subtests of the WIAT. Univariate analyses (ANCOVA) and, subsequent, post hoc comparisons revealed significant posttest gains for the Math-trained control group compared to both PAT- and WAT-trained groups on a measure of Numerical Operations ($p < .05$). No significant differences (*ps* > .05) between treatment groups were found on a measure of Mathematical Reasoning. The magnitude of effect sizes for Numerical Operations were large between Math- and WAT-trained groups *ES* = .86 (Math > WAT), moderate between Math- and PAT-trained children *ES* = .77 (Math > PAT), and small between reading treatment groups *ES* = .17 (PAT > WAT).

In summary, children in the control group acquired improved math computation skills as a result of their specific training in math. These results add discriminant validity to the present study because PAT- and WAT-trained children acquired measurably improved skills only in areas related to reading, which was the focus of their training, and not in areas related to math.

Time Series Analyses

A multiple baseline across schools design was used to examine children's growth in oral reading fluency for each reading intervention approach. The primary unit of analysis for this data was the *group mean* during baseline and treatment phases because reading instruction was delivered in small groups of five children and the interactions among children may have influenced treatment outcomes (Glass & Hopkins, 1984). Table 6 shows the means and standard deviations across baseline and treatment phases for each treatment group at each school. As shown in Figure 1 and Figure 2, growth in oral reading speed and accuracy was observed across schools and treatment groups. Although each group improved in oral reading fluency and progressed from a frustration reading level (i.e., 29 median words correct per minute) to an instructional reading level (i.e., 30–49 median words correct per minute) by the end of the reading interventions, all reading intervention groups remained at a middle of first grade reading level (Deno & Mirkin, 1977).

For PAT-trained groups, the number of CWPM increased by 13.3 (School B), 20.0 (School C), and 20.1 (School A), and the percentage of words read accurately increased by 17.0% (School C), 24.7% (School A), and 30.9% (School B) from baseline to the end of treatment. For WAT-trained groups, the number of CWPM increased by 13.2 (School A), 14.3 (School B), and 18.5 (School C), and the percentage of words read accurately increased by 18.3% (School C), 20.0% (School A), and 28.8% (School B) from baseline to the end of treatment. As can be seen in Figures 1 and 2, the slopes are slightly steeper for PAT-trained groups, than for WAT-trained groups, suggesting a faster rate of growth in the number of words read correctly per minute per week. However, no significant differences were found between the slopes, $p > .05$.

Individual Growth Estimates

In order to address interindividual differences in intraindividual change, the mean rate of change for each of the two reading intervention groups (i.e., PAT $N = 15$; WAT $N = 15$) was calculated. Because of sample size and no significant differences between slopes, the two groups were collapsed for the subsequent analysis. Estimates of growth were made based on the extent to which individual children differed from the mean rate of growth. Also, because of sample size, the subsequent regression analysis focused only on the correlation between individual variables, rather than considering all pretest variables. Estimates of change in speed and accuracy of oral reading were obtained from 6 waves of data taken from weekly measurements during the interventions. The average estimated slope for the PAT-trained group was 2.59 (SE = .24) for speed and 3.13 (SE = .39) for accuracy, and the average estimated slope for the WAT-trained group was 2.22 (SE = .24) for speed and 2.91 (SE = .39) for accuracy. Both PAT- and WAT-trained groups yielded significant rates of growth in both speed and accuracy, compared to chance. For PAT-trained groups, $t(148) = 10.88$, $p < .0001$, and $t(148) = 8.00$, $p < .0001$, for speed and accuracy, respectively. For WAT-trained groups, $t(148) = 9.28$, $p < .0001$, and $t(148) = 7.44$, $p < .0001$, for speed and accuracy, respectively. There were no significant differences ($ps > .05$) between PAT-trained and WAT-trained groups for speed or accuracy of oral reading.

Table 7 shows the correlation's (df = 28) between pretest variables and growth rate in oral reading fluency. Because of sample size, only coefficients greater than .50 were considered meaningful. For growth rates related to oral reading speed, Table 7 shows that correlations of high magnitude (> .50) were related to context-free word lists from the PAT and WAT training programs and from the Word Identification subtest of the WRMT-R. None of the process measures (i.e., working memory, TOPA, phonemic deletion) were significantly related to rate of oral reading (all coefficients < .25). For growth rates related to oral reading accuracy, only the WAT word list yielded a coefficient above magnitude .50. Taken together, these results suggest that initial word identification skill best correlates with individual growth in oral reading fluency. Table 8 provides the intercorrelations among the pre- and posttest variables included in this analysis. With a sample size of 30 for the two reading intervention groups combined, any correlation above .35 is statistically reliable ($p < .05$), and with a sample size of 15 in the control group, any correlation above .50 is statistically significant ($p < .05$). One aspect of the correlations warrant mention. As can be seen in Table 8, the correlations between pre- and posttest reading and reading related measures are significantly stronger in the control group than in the intervention groups, suggesting that the training had a significant impact on the beginning reading skills within the reading intervention groups.

In order to provide a visual presentation of the way that children differed from one another in their growth in oral reading speed and accuracy, individual growth curves are plotted in Figure 3 for children in the two reading intervention groups. These growth curves were plotted using data from

TABLE 6
Oral Reading Fluency: Baseline and Treatment Phases

	School A				School B				School C			
	CWPM		% Accuracy		CWPM		% Accuracy		CWPM		% Accuracy	
Phase	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Baseline												
PAT group	14.7	4.9	60.5	15.6	8.9	3.7	50.2	14.1	18.4	9.7	67.5	11.9
WAT group	14.4	6.8	58.4	17.2	8.7	3.9	53.4	13.7	18.1	6.3	66.7	8.1
Treatment												
PAT group												
week 1	19.0	8.5	67.3	17.7	12.4	4.8	55.8	14.9	23.6	13.8	73.7	11.5
week 2	20.2	8.1	71.2	17.6	15.2	5.5	69.4	9.2	25.4	13.5	73.9	9.8
week 3	23.8	9.9	75.9	17.3	15.8	5.1	68.0	13.5	27.0	14.5	76.2	10.4
week 4	27.2	11.6	78.5	16.4	18.2	5.1	71.8	12.9	30.6	17.8	80.7	11.1
week 5	29.2	11.5	77.6	14.6	19.4	5.8	78.8	10.3	33.4	17.9	81.5	9.7
week 6	34.8	14.4	85.2	12.7	22.2	5.8	81.1	12.1	38.5	16.1	84.5	5.1
WAT group												
week 1	17.0	8.2	64.9	18.6	12.4	4.2	60.1	15.6	23.2	9.6	74.6	9.8
week 2	18.6	8.3	69.0	18.7	13.2	4.0	64.4	10.7	26.4	11.6	77.3	11.9
week 3	20.6	8.6	70.7	13.4	15.6	3.9	65.5	17.3	30.2	16.2	75.3	12.0
week 4	22.4	13.3	77.8	13.2	17.6	3.4	73.7	15.5	33.0	15.2	80.5	10.5
week 5	24.4	8.4	78.5	13.9	19.8	3.7	78.3	4.3	35.6	15.7	83.0	9.2
week 6	27.6	10.2	78.4	16.8	23.0	5.3	82.2	7.0	36.6	15.7	85.0	6.7

Note. All data are group averages (N = 5). Baseline averages were obtained as follows: School A is based on three baseline data points, School B is based on five baseline data points, and School C is based on seven baseline data points. PAT = phonological awareness training; WAT = word analogy training; CWPM = correct words per minute.

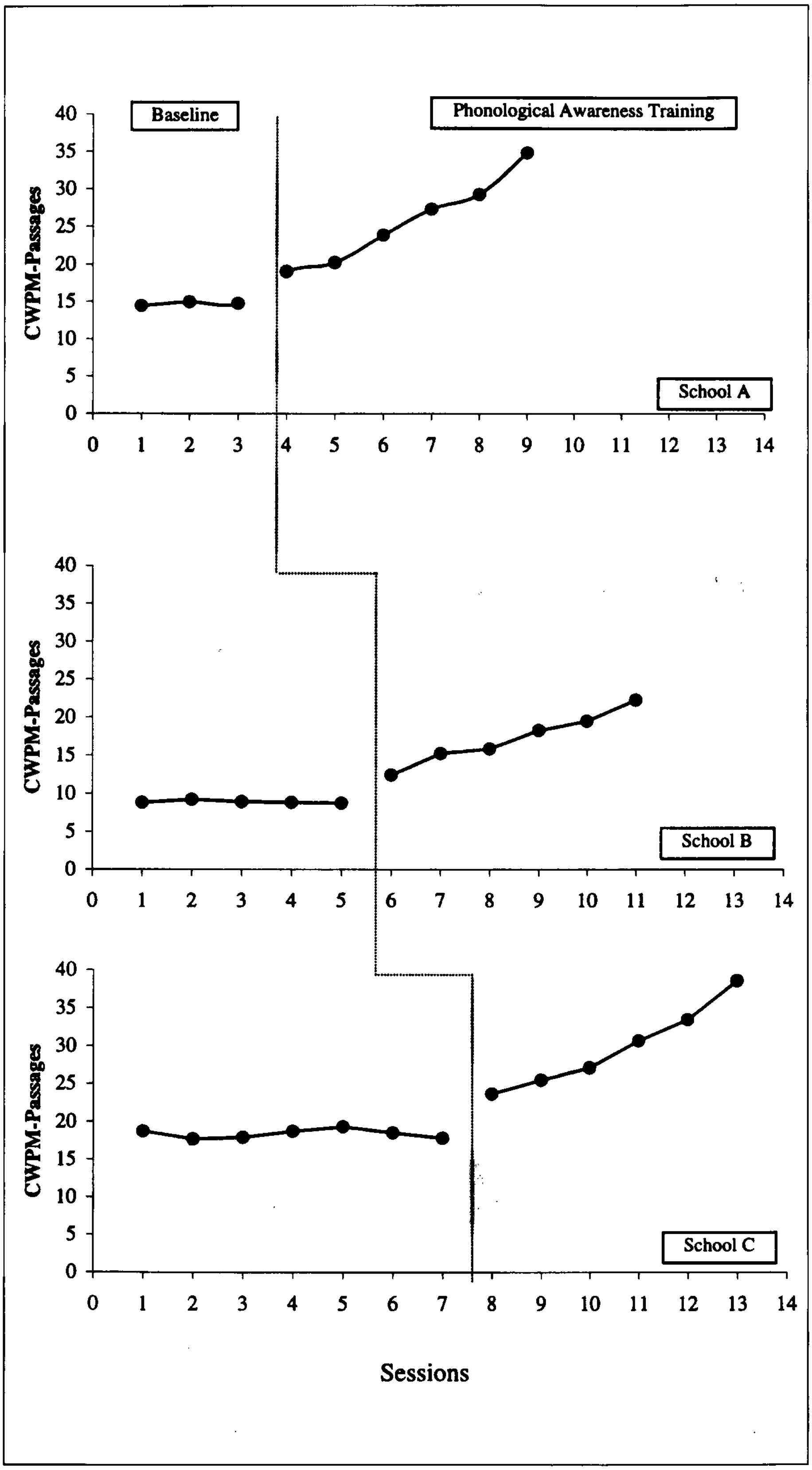

FIGURE 1. Mean number of correct words per minute across schools for phonological awareness trained groups.

the end of the first week of training and the end of the last week of training. As shown in Figure 3, there was considerable variability in response to the reading interventions for both speed and accuracy of oral reading within the trained groups.

Discussion

This study addressed three issues related to reading intervention. The first issue that motivated this study was whether research-based reading interventions would be effective in the natural setting of public schools and, in particular, with second-grade children identified with reading disabilities. That is, we wondered whether the positive treatment outcomes obtained under tightly controlled clinical settings were robust enough to be replicated in typical school environments. Based on our results, the answer to this question is a resounding, yes. The average effect size for each reading intervention group (in comparison to the math-trained control group), across all reading and reading-related outcome measures, is greater than 1.00, which according to Cohen's criteria is a substantial effect size (Cohen, 1969). Although children's reading difficulties were not completely remediated after only a short-term intervention, children in both reading programs achieved significant gains in beginning reading skills in comparison to math-trained children.

The second issue considered was whether differences in effectiveness existed between the two reading intervention approaches on measures of trained content. Results indicate that *both* phonological awareness training, which focused on the smallest unit of phonemes within oral language activities and some written words, and word analogy training, which emphasized the larger unit of onset-rime within oral and written language activities, were effective after six weeks when compared to the control condition. Both reading interventions led to substantial growth in phonological awareness and word identification skills in mid-year second-grade children with serious reading difficulties. Specifically, on a standardized measure of phonological awareness, children in both reading interventions showed increased awareness of the sounds in spoken words, although children in the PAT group made significantly greater gains in this domain, which was the primary focus of their training. As a group, PAT-trained children improved by 20.5 standard score points, and WAT-trained children improved by 10.0 standard score points after training. Although the phonemic structure of words was not explicitly taught to children in the WAT group, the program's emphasis on rhyme and use of orthographic analogies to decode and spell unfamiliar words led to generalized awareness that words are made up of individual sounds. This finding is congruent with previous training studies that have shown that phonological awareness can be developed directly through systematic oral language activities or indirectly through written language activities that integrate phonemic awareness activities with reading and spelling instruction (Adams, 1990; Torgesen et al., 1997). On measures of instructed, context-free words (one-syllable words with high-frequency spelling patterns) from their respective training programs, both reading intervention groups yielded large effect sizes (> 1.0) in comparison to the control group. These results, along with the finding below that both reading groups outperformed the control group on a measure of word attack skills after intervention, indicates that children in both reading programs acquired improved word analysis skills following systematic, phonologically-based intervention. Although the two reading intervention approaches focused on different subsyllabic units of word analysis (i.e., phonemes in PAT, onsets and rimes in

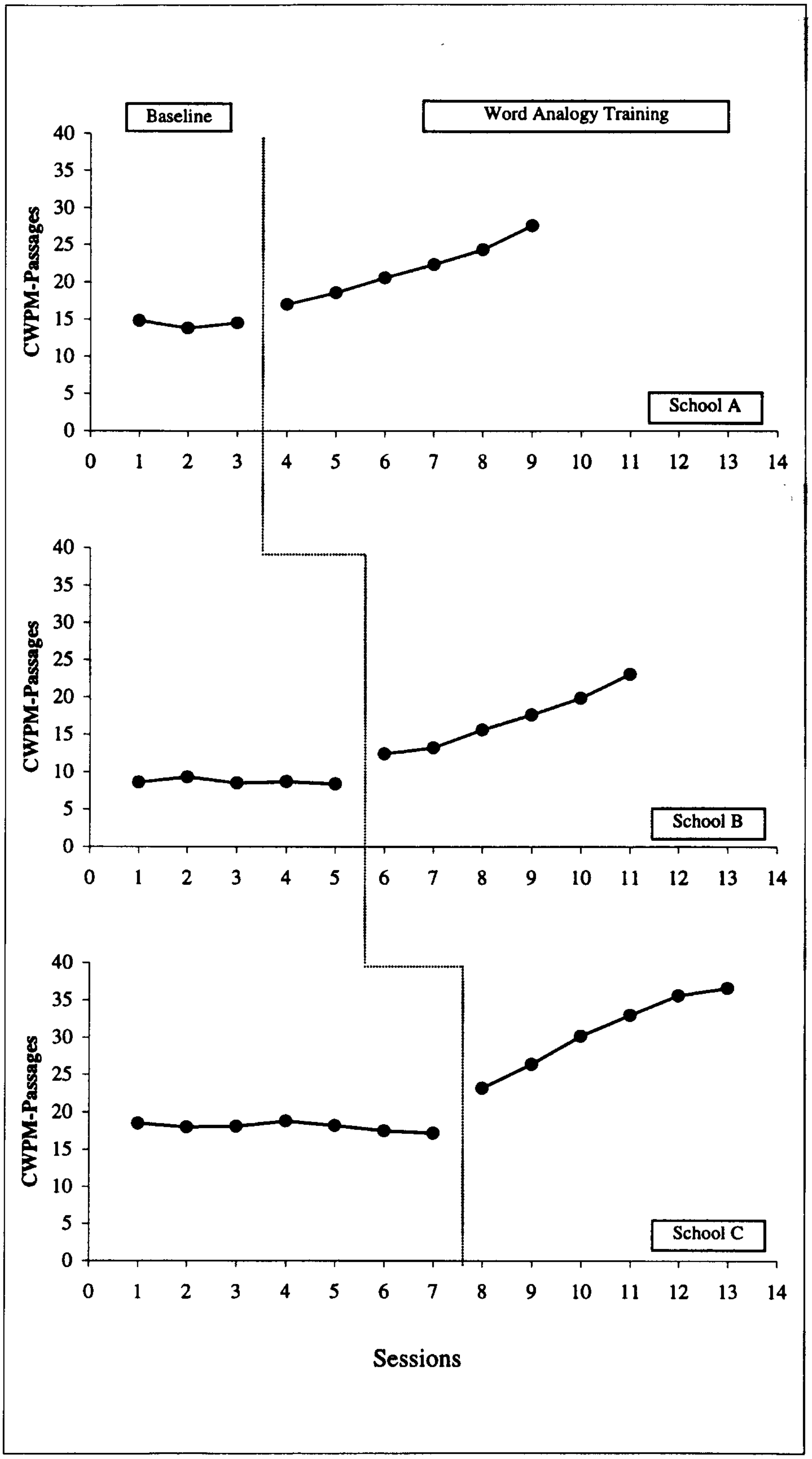

FIGURE 2. Mean number of correct words per minute across schools for word analogy trained groups.

WAT), each resulted in significant gains in word identification skills. Children in both reading groups who struggled to read high frequency CVC words before training were able to identify a substantially increased number of these words after training.

A final issue addressed in this study was whether differences existed between the two reading intervention approaches on transfer of learning, the true test of whether intervention is effective. Our findings suggest that children in both reading intervention programs were equally able to apply their newly acquired skills to uninstructed reading and reading-related material on several measures of generalization. On transfer of learning to context-free words, children in both remedial reading programs successfully applied their new word analysis skills to identifying unfamiliar words from the other reading intervention program. Both PAT-trained and WAT-trained children more than doubled the number of uninstructed words they could identify from words taught in the other reading intervention program. In addition, WAT-trained children were equally effective as PAT-trained children in identifying target words from the PAT program. In this study, transfer of learning could be characterized as "near" transfer because it only extended to similarly spelled rhymes of regular words (e.g., *bat* and *hat*). Neither reading intervention was effective in predicting word identification on a standardized measure that included both regular and irregular words, as well as both monosyllabic and multisyllabic words. On transfer of learning to a measure of word attack, children in both reading intervention groups displayed increased alphabetic reading skills after their respective training programs. This suggests that both reading intervention approaches improved children's knowledge of sound–symbol relations. The only way children can decipher nonsense words such as *plip* and *twem*—words that are not in their sight word vocabulary—is by applying phonologically-based decoding skills (Rack et al., 1992). Thus, in contrast to Lovett et al., (1994) the present study found that WAT, as well as PAT, enhanced phonological skills. These results are encouraging because a persistent problem reported in the literature on treatment of reading disabilities is the lack of transfer of learning even after intensive intervention (Lovett, Ransby, & Barron, 1988; Lovett et al., 1990; Uhry & Shepherd, 1997; Vellutino & Scanlon, 1987). Thus, the present findings add to a small but growing body of evidence showing that children with phonologically-based reading difficulties are able to generalize what they have been taught to new situations (Hatcher, Hulme, & Ellis, 1994; Lovett et al., 1994; Torgesen et al., 1997).

On experimental measures of phonological working memory, it was a surprise that children in both remedial reading programs significantly improved their ability to remember words, in sequential order, at the conclusion of the interventions. One interpretation of this finding is that learning to read improves a child's ability to convert words into sound-based representations, which, as a consequence, enhances verbal memory (Wagner & Torgesen, 1987). However, it is hard to believe that six weeks of reading intervention led to improved phonological processing abilities (as far as we know, though, no one has investigated the effects of learning to read on verbal memory performance). A more likely explanation is that children's successful experiences learning to read during the interventions increased their motivation to learn, which subsequently improved their attention and short-term memory performance (Morrison, Smith, & Dow-Ehrensberger, 1995; Torgesen, 1977).

Finally, children in both reading interventions made significant gains in oral reading fluency, both in speed and accuracy, on curriculum-based reading passages in comparison to children in the control group. Children in the reading intervention groups improved from a frustration reading level to an instructional reading level on middle

TABLE 7
Pretest Variables as Predictors of Growth Rate in Oral Reading Fluency: Correct Words Per Minute (CWPM) and Accuracy

Predictor	CWPM correlation coefficient	Accuracy correlation coefficient
IQ	−.02	.14
Vocabulary	.11	.14
Information	.10	−.08
Digit Span	−.09	−.04
Working Memory-Rhyming Words	.21	.23
Working Memory-Sentence Span	.14	.15
Test of Phonological Awareness	.16	.13
Phonemic Deletion	.08	.03
PIAT-R Spelling	.43*	.30
WRMT-R Word Identification	.53**	.43*
WRMT-R Word Attack	.23	.15
WRMT-R Passage Comprehension	.47*	.40*
PAT Word List	.52**	.41*
WAT Word List	.67****	.54**
SSRS Academic Competence	.38*	.36

Note. FSIQ = full-scale IQ measured by Wechsler Intelligence Scale for Children–3rd Edition; PIAT-R = Peabody Individual Achievement Test–Revised; WRMT-R = Woodcock Reading Mastery Test–Revised; PAT = phonological awareness training; WAT = word analogy training; SSRS = Social Skills Rating System.
*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$.

TABLE 8

Correlations Among Pretest and Outcome Variables for the PAT- and WAT-Trained Groups Combined and the Math-Trained Control Group

	Reading Intervention Groups																									
Variable	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**	**14.**	**15.**	**16.**	**17.**	**18.**	**19.**	**20.**	**21.**	**22.**	**23.**	**24.**	**25.**	**26.**
1. Full Scale IQ	1	.45	.49	.44	–.16	–.39	.25	.21	–.10	.05	–.05	.35	–.12	–.15	–.17	–.18	–.28	–.13	.01	–.14	–.30	–.01	–.22	–.26	.03	.17
2. *Voc*	.43	1	–.01	–.09	–.17	–.15	.06	.46	–.04	–.02	–.04	.24	–.34	–.43	–.24	–.23	.04	–.05	–.33	–.31	–.34	–.21	–.28	–.17	.28	.44
3. *Info*	.52	.07	1	.29	–.04	–.39	–.01	–.25	–.16	.21	.10	.11	.24	.23	–.01	–.06	–.13	–.01	.08	–.14	–.07	.19	.13	–.11	–.16	.04
4. DS	.65	.15	.25	1	–.08	–.06	.38	.11	–.06	.08	.10	.24	.21	.24	.30	.25	.08	.21	.42	.28	–.08	.19	.08	.03	–.10	–.02
5. Working Memory: Rhyming Words–pre	.03	–.02	.34	–.51	1	.52	.36	.02	.07	.31	.15	.08	.20	.05	.09	.11	.22	.34	.27	.05	.15	.12	.11	.02	–.01	–.16
6. Working Memory: Rhyming Words–post	.66	.28	.64	.07	.73	1	.26	.24	.08	.23	–.10	–.08	.02	–.06	.16	.14	.09	.13	.18	.08	.09	–.08	.09	–.14	–.01	–.13
7. Working Memory: Sentence Span-pre	–.11	–.25	.10	–.14	.35	.26	1	.50	.07	.30	.04	.23	.04	–.00	.09	.05	–.01	.02	.26	–.03	.04	.05	.10	–.04	–.12	–.23
8. Working Memory: Sentence Span-post	.58	.18	.44	.27	.15	.51	.35	1	.19	.10	–.22	.32	–.09	–.16	–.08	–.16	–.21	–.23	.09	–.13	–.12	–.12	–.12	–.09	–.00	–.06
9. TOPA: pre	.09	.52	–.32	–.05	–.14	–.16	–.32	–.11	1	.25	–.04	–.20	.22	.12	–.08	–.11	–.16	.11	.14	.00	–.01	–.01	.05	–.05	.23	.02
10. TOPA: post	.34	.56	–.11	.02	–.01	.05	–.44	.09	.79	1	.06	.21	.31	.31	.09	.20	.13	.28	.32	.15	.11	.24	.06	–.14	.00	.05
11. Phonemic Deletion: pre	–.01	.18	.07	–.14	.27	.07	–.13	.08	.54	.59	1	.15	.29	.20	.29	.30	.43	.33	.12	.35	.08	.21	.22	.30	.19	.04
12. Phonemic Deletion: post	.08	.15	.05	–.21	.46	.26	–.08	.07	.52	.60	.92	1	.36	.37	.50	.39	.23	.27	.48	.40	.36	.45	.33	.30	.27	.40
13. Spelling: pre	.08	.09	–.07	–.39	.64	.41	.05	.13	.32	.34	.61	.71	1	.85	.65	.58	.17	.59	.67	.55	.65	.70	.71	.51	.03	.08
14. Spelling: post	.34	.16	.35	–.18	.67	.62	.03	.42	.16	.33	.66	.72	.88	1	.64	.64	.15	.61	.61	.66	.74	.79	.73	.52	–.10	.02
15. Word Identification: pre	.11	.04	.35	–.10	.56	.38	–.08	.01	.23	.19	.65	.61	.70	.78	1	.89	.49	.62	.69	.78	.75	.73	.82	.74	.16	.40
16. Word Identification: post	.35	.14	.41	.06	.49	.47	–.20	.12	.25	.33	.69	.66	.71	.85	.96	1	.51	.70	.62	.86	.66	.74	.73	.72	.22	.42
17. Word Attack: pre	.49	.47	.20	.03	.45	.54	–.33	.26	.49	.68	.70	.79	.70	.79	.64	.77	1	.56	.13	.43	.30	.34	.21	.38	.24	.36
18. Word Attack: post	.75	.53	.33	.18	.25	.58	–.24	.57	.37	.72	.45	.55	.45	.64	.25	.48	.82	1	.38	.62	.52	.59	.55	.48	.13	.25
19. Passage Comprehension: pre	.39	.54	.29	.29	.12	.26	–.38	–.02	.42	.51	.64	.52	.38	.53	.70	.79	.70	.46	1	.68	.54	.62	.60	.47	.22	.26
20. Passage Comprehension: post	.52	.59	.21	.33	.11	.33	–.43	.17	.51	.70	.70	.65	.40	.54	.52	.68	.87	.72	.88	1	.58	.68	.60	.61	.13	.31
21. PAT word list: pre	–.05	.41	.07	–.27	.25	.10	–.05	–.18	.24	.28	.50	.37	.47	.42	.54	.53	.39	.22	.66	.47	1	.81	.86	.74	.04	.21
22. PAT word list: post	.01	.37	.08	–.19	.12	.01	–.10	–.19	.39	.42	.55	.42	.40	.34	.47	.50	.38	.28	.63	.50	.95	1	.75	.68	.08	.34
23. WAT word list: pre	.10	.31	–.08	.22	.16	.08	–.08	–.14	.47	.41	.60	.50	.37	.33	.64	.63	.55	.17	.78	.69	.53	.52	1	.80	.11	.30
24. WAT word list: post	.12	.24	–.05	.24	.19	.12	–.13	–.17	.46	.37	.59	.51	.38	.34	.68	.66	.58	.16	.76	.69	.46	.46	.98	1	.15	.38
25. Academic Competence: pre	.47	.45	.00	.02	.23	.36	–.22	–.17	.40	.53	.19	.34	.45	.37	.28	.41	.48	.49	.49	.41	.40	.41	.31	.29	1	.76
26. Academic Competence: post	.39	.53	–.05	.09	.22	.31	–.27	–.29	.44	.54	.32	.43	.42	.34	.37	.48	.57	.43	.67	.59	.50	.48	.56	.54	.93	1
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**	**14.**	**15.**	**16.**	**17.**	**18.**	**19.**	**20.**	**21.**	**22.**	**23.**	**24.**	**25.**	**26.**
	Math-Trained Control Group																									

Note. Full-scale IQ was measured by Wechsler Intelligence Scale for Children–3rd Edition; Voc = vocabulary subtest; Info = information subtest; DS = digit span subtest of Wechsler Intelligence Scale for Children–3rd Edition; TOPA = Test of Phonological Awareness; PAT = phonological awareness training; WAT = word analogy training.

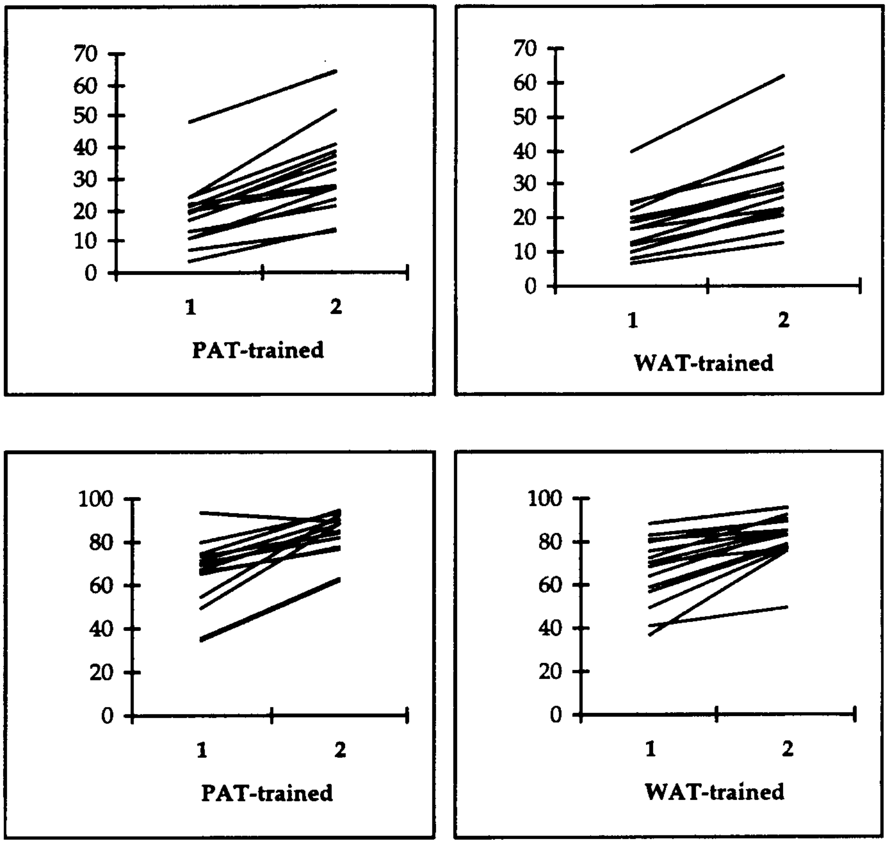

FIGURE 3. Individual growth curves, plotted using data from the end of the first week of training (1) and the end of the last week of training (2), in correct words per minute and percent accuracy for phonological awareness trained and word analogy trained groups.

of first grade reading passages. However, there was substantial individual variation in response to intervention. While most children in each reading intervention group, 80% in PAT and 73% in WAT, significantly improved the rate and accuracy with which they could read connected text, some children improved only slightly (see O'Shaughnessy & Gresham, 1999). This finding is consistent with other recent treatment-outcome studies, which have also found a sizeable percentage of children who respond poorly to even intensive, informed intervention (Torgesen et al., 1992; Uhry & Shepherd, 1997; Vellutino et al., 1996). Oral reading fluency can be a stringent measure of transfer of learning because the reading passages may or may not correspond to the content of instruction (Hintze, Shapiro, & Lutz, 1994). In this case, reading passages came from literature-based basal readers, which typically contain a relatively small percentage of decodable words. Therefore, there was probably some mismatch between what was taught and the number of decodable words in the reading passages that would provide an opportunity for children to practice the strategies they had learned in the reading interventions (e.g., Adams, 1990; Juel & Roper-Schneider, 1985). The best predictor of growth in oral reading speed and accuracy was a child's initial level of word identification skill (i.e., reading context-free words). This finding is also consistent with current research which suggests that the level of phonological and orthographic skills a child *brings* to a reading intervention are the most important determinants of their ability to benefit from an intervention (e.g., Foorman et al., 1997; Torgesen & Davis, 1996; Vellutino et al., 1996). Thus, the widely reported "rich-get-richer" effects seen between children who are typical readers and children who are poor readers (e.g., Juel, Griffith, & Gough, 1986; Stanovich, 1986; for a different view see Shaywitz et al., 1995) also appears to apply to children who are poor readers compared to children who are even poorer readers.

There were several limitations to the present study. First, the interventions were implemented for too brief a period of time. All of the children continued to need reading intervention at the conclusion of the study, although some more than others. In addition, the duration of intervention was probably too brief to determine whether the two reading intervention approaches would lead to differential treatment outcomes. A second limitation of this study was that the interventions were implemented by paraprofessionals instead of classroom teachers. Children experiencing problems learning to read need the help of highly trained teachers in their classrooms. In reality, though, paraprofessionals are widely used in public elementary schools to teach a sizeable portion of remedial instruction to students at risk and students with special needs. With adequate training and ongoing supervision, this study showed that paraprofessionals could successfully implement research-based reading interventions. However, a better model for future study is one in which classroom teachers are trained in empirically validated reading interventions and provided ongoing consultation while they implement interventions in their classrooms. Under this model, children would more likely benefit from incidental teaching and reinforcement of previously taught skills throughout the school day. Moreover, because many teachers report they lack the knowledge and skills needed to teach a classroom of diverse learners (Moats, 1994; Lyon, Vaasen, & Toomey, 1989), this model would help disseminate research-based "best practices" for children with reading disabilities.

A next step in this line of research will be to investigate the model described above, as well as the strengths of the two reading interventions together, providing intensive PAT *followed by* WAT. A comprehensive approach, incorporating several levels of word analysis (phoneme and onset-rime) and combining direct instruction of specific skills with the integration of these skills in contextualized reading and spelling activities, may prove to be an effective way to stimulate the development of phonological awareness and an understanding of the alphabet principle in even our poorest readers. Current knowledge supports this idea (e.g., Adams, 1990; Benson, Lovett, & Kroebler, 1997; Ehri & Robbins, 1992; Lovett et al., 1994; Pressley, 1998).

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AUTHORS' NOTES

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