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Interventions for Reading Difficulties

A Comparison of Response to Intervention by ELL and EFL Struggling Readers

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This article explores whether struggling readers from different primary language backgrounds differ in response to phonologically based remediation. Following random assignment to one of three reading interventions or to a special education reading control program, reading and reading-related outcomes of 166 struggling readers were assessed before, during, and following 105 intervention hours. Struggling readers met criteria for reading disability, were below average in oral language and verbal skills, and varied in English as a first language (EFL) versus English-language learner (ELL) status. The research-based interventions proved superior to the special education control on both reading outcomes and rate of growth. No differences were revealed for children of EFL or ELL status in intervention outcomes or growth during intervention. Oral language abilities at entry were highly predictive of final outcomes and of reading growth during intervention, with greater language impairment being associated with greater growth.

Keywords: *reading disabilities; English as a second language; reading remediation; language impairment; word identification skills*

Dramatic increases in the number of English-language learners (ELLs) in North American schools have been well documented, with even greater growth projected in the coming decades. Students who are language minorities have been identified as the fastest growing segment of the school population (Wagner, Francis, & Morris, 2005). In the United States, ELLs accounted for an estimated 9.6% of total public school enrollment in 2000 to 2001 (U.S. Department of Education, 2004), more than double that of the previous decade. It has been estimated that by 2030, up to 40% of the school population may speak English as a second language (U.S. Department of Education, 2003). In Canada, in 2001, 18.4% of the general population was born outside the country (Statistics Canada, 2001), compared to 11.5% of the U.S. population (Schmidley, 2003). The growth in immigration from non–English-speaking countries has posed special challenges to publicly funded school systems across North America. Educational issues are particularly complex with respect to effective literacy instruction in the English language and appropriate identification and intervention for students who struggle with reading.

Statistics provided by the U.S. Department of Education (2004) and U.S. Department of Commerce (2004) have identified non–English-speaking students as the group characterized by the highest drop-out rates, the lowest achievement scores, and the highest rates of poverty (Gunderson & Clarke, 1998; McCardle, Mele-McCarthy, Cutting, Leos, & D'Emilio, 2005). The immediacy of their educational needs has motivated a research agenda and funding in the United States to better understand the successful learning trajectories of some ELL students and effective interventions for literacy and numeracy instruction and to evaluate the success of bilingual and immersion programming. Recently, a special issue of the journal *Learning Disabilities: Research and Practice* (2005, Vol. 20, Issue 1) was devoted to discussion of the complexities of identifying learning disabilities in ELL students and the development of a set of research priorities for the future (McCardle et al., 2005).

The demographics of the ELL student population differ between the United States and Canada. In the United States, the non–English-speaking population is predominantly Spanish (77% to 80%; Zehler et al., 2003), whereas greater linguistic diversity characterizes the ELL student population in Canada. In one large Canadian study in progress (Chiappe, Siegel, & Gottardo, 2002; Lesaux & Siegel, 2003; Lipka & Siegel, 2007), the native language of the ELL sample includes 30 different languages, the most frequent being Chinese, Farsi, Slavic, Japanese, and Korean, followed by Filipino and Tagalog. Another demographic difference concerns the socioeconomic status (SES) profiles of ELLs in Canada and the United States. Most studies of ELL students in Canada include children from middle-class backgrounds; this is in marked contrast to the United States, where a majority of ELL students are from disadvantaged SES backgrounds (Lipka, Siegel, & Vukovic, 2005). One study of American ELL students reported that 70% were eligible for free or reduced price lunches compared to an average rate of 38% from the same schools (August & Hakuta, 1997).

Despite these differences, there have been some consistent findings from research examining the literacy development and English reading skills of ELL students from both countries. Although large achievement gaps have been identified between White middle-class students and ELL students in American schools (U.S. Department of Education, 2003), undoubtedly confounded by SES factors, results from cross-sectional and longitudinal studies of large ELL and English as a first language (EFL) Canadian samples have revealed that learning to read in a second language need not be considered a risk factor (Lipka & Siegel, 2007; Lipka et al., 2005). There is accumulating evidence that young ELL learners often attain equivalent levels of reading and spelling achievement in the early grades (Geva, Yaghoub-Zadeh, & Schuster, 2000; Lesaux & Siegel, 2003; Wang & Geva, 2003). Recent data have been reported to extend this observation to the realm of reading efficiency or fluency. Geva and Yaghoub-Zadeh (2006) compared ELL and EFL children in Grade 2 on tests of word and text-reading efficiency and examined the cognitive and reading-related predictors of reading efficiency in each sample. Even though the two samples differed in terms of their oral language proficiency, the ELL and EFL children read the words and simple texts with equivalent efficiency.

Evidence on the phonological processing skills of ELL students relative to those of their EFL peers has been inconsistent. Some studies have reported equivalent levels of phonological performance for ELL children in the Kindergarten through Grade 2 range (Chiappe, Siegel, & Wade-Wolley, 2002; Lipka et al., 2005), and others (Lipka & Siegel, 2007) have found that ELL children of the same ages lag behind their EFL peers in phonological skills. There has been some suggestion of positive cross-linguistic transfer for children of certain native languages (e.g., the highly regular Italian language; D'Angiulli, Siegel, & Serra, 2001). One study of Spanish-speaking ELL students in California found that phonological awareness had a high degree of transfer from Spanish to English and was a reliable predictor of word identification performance (Lindsey, Manis, & Bailey, 2003).

There have been more consistent results from studies of the syntactic awareness and vocabulary knowledge of

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ELL students. Syntactic awareness tasks reveal ELL students to be at a significant disadvantage, although this disadvantage does not reliably predict poorer reading achievement in the early grades (Chiappe, Siegel, & Wade-Wolley, 2002; Gottardo, Stanovich, & Siegel, 1996; Lipka et al., 2005). As expected, a disadvantage in the breadth and depth of English vocabulary knowledge characterizes ELL students (August, Carlo, Dressler, & Snow, 2005; Verhallen & Schoonen, 1993), and this gap is not easily bridged. It is estimated that first-language students bring a vocabulary of 5,000 to 7,000 words to reading instruction (Biemiller & Slonim, 2001). There has been relatively little research examining the English vocabulary development of ELL children, implications for reading comprehension in the later grades, and instructional programs designed to build the vocabularies of ELL students.

These studies referenced above have addressed the relationship between oral language proficiency and reading skill in ELL students and have revealed that, although the relative contributions of phonological awareness, rapid naming, and accurate word identification may not be identical in the development of fluent reading skills in ELL and EFL students (Geva & Yaghoub-Zadeh, 2006), similar levels of early reading skill can be achieved. Research that has compared the processing profiles of ELL and EFL students experiencing reading acquisition problems has identified the same set of deficient cognitive and linguistic processes as being associated regardless of native language status (Brown & Hulme, 1992; Doctor & Klein, 1992; Lipka et al., 2005). In addition to standardized reading and spelling achievement tests, it would appear that assessments of reading disorder in ELL students should include the same types of phonological processing, syntactic awareness, and working memory measures as would be used with EFL students (Geva & Yaghoub-Zadeh, 2006; Klingner, Artiles, & Méndez Barletta, 2006; Lipka et al., 2005). Available data would also suggest that oral language proficiency in English, although important to evaluate, may not be a reliable indicator of reading difficulties at least in the early grades. As Geva and Yaghoub-Zadeh (2006) caution, "simplistic notions of L2 [second language] reading performance that emphasize primarily oral language proficiency need to be refined" (p. 52).

Despite the importance of similar cognitive and linguistic processes to the development of reading skills for learners of different first languages, little is known of what interventions are most effective for ELL students with significant reading difficulties (Vaughn, Mathes, Linan-Thompson, & Francis, 2005). With increasing numbers of ELL students referred for special education services (McCardle et al., 2005), there is a great need for controlled evaluations of interventions for ELL struggling readers (Vaughn, Linan-Thompson, Mathes, Cirino, Carlson, Francis, et al., 2006; Vaughn, Linan-Thompson, Mathes, Cirino, Carlson, Pollard-Durodola, et al., 2006). Vaughn and her colleagues (2005) suggest that effective intervention should include not only the components already identified as critical for remediation of EFL struggling readers, but also instruction related to language development of ELL students and use of the best validated English as a Second Language (ESL) instructional practices.

Gerber and his colleagues (Gerber et al., 2004; Vaughn, Linan-Thompson, Mathes, Cirino, Carlson, Francis, et al., 2006) have questioned the expectation that ELLs can learn alphabetic decoding skills when their experiences with English phonology are inadequate. In a small-scale kindergarten intervention program, this group evaluated the efficacy of intensive phonological awareness instruction for 16 low-SES ELL students from Spanish-speaking homes (Leafstedt, Richards, & Gerber, 2004). Instructed students outperformed a curricular control group on measures of phonological awareness and word reading after 300 minutes of small-group instruction, but the superiority was significant only for middle and higher performing ELL children at entry to kindergarten. Another study with kindergarten children designated as at risk on bilingual phonological processing measures studied the impact of brief supplemental English reading instruction. Although not a randomly assigned intervention study, the data offered preliminary support for the value of the instruction when reading progress was assessed at the end of first grade (Gerber et al., 2004). These results are based on very small samples, however, and can be considered only suggestive until more rigorous controlled evaluations are undertaken. In fact, a best-evidence synthesis of reading programs for ELL students reported a dearth of rigorous research on what constitutes effective reading instruction for ELLs (Slavin & Cheung, 2003). The belief is that ELL students at risk need programs that implement explicit direct instruction in phonological awareness and the alphabetic principle and supplemental instructional support over a period of months.

In the present report, we address the issue of what constitutes effective remediation for school-age struggling readers for whom English is a second language. The present research addresses the question of whether struggling readers from different linguistic backgrounds differ in their response to phonologically based remedial reading programs. Reading and reading-related outcomes are examined following random assignment of 166 struggling readers to one of three reading intervention programs or to a special education curricular control program. All of the struggling readers met criteria for reading disability (RD); some were EFL and some were ELL students.

Method

Participants

These data were collected over 4 years in 16 elementary schools from a large multicultural and linguistically diverse urban school district in Canada, the Toronto Catholic District School Board. In Year 1, 15 children participated; in Year 2, 61; in Year 3, 83; and in Year 4, 7. Participating schools had been nominated by school district administrators to allow equal geographical representation across the city. The schools represented a cross-section of socioeconomic and cultural backgrounds as confirmed by school district demographic data and background questionnaires completed by the parents of participating students.

Children from Grades 2-8 were referred to the study by teachers concerned about their reading achievement. After receiving written consent from a parent or legal guardian and verbal assent from the student, a brief screening assessment of the child's word identification, word attack, and receptive vocabulary skills was conducted by research psychometrists from the Learning Disabilities Research Program of The Hospital for Sick Children in Toronto, Canada. To qualify for participation, students had to score 1 standard deviation (*SD*) or more below age norm expectations (standard score < 85) on the averaged standard score obtained from three reading achievement tests (Woodcock Reading Mastery Tests–Revised [WRMT-R] Word Identification and Word Attack Subtests [Woodcock, 1987]; Wide Range Achievement Test, Third Edition [WRAT-3 Reading Subtest, Blue form; Wilkinson, 1993]). Children with histories of significant behavioral disorder, significant absenteeism (absent > 15 days of intervention), hearing impairment (> 25 dB at 500+ Hz bilaterally), uncorrected visual impairment (> 20/40), chronic medical or neurological conditions (e.g., seizure disorder, developmental neurological conditions, acquired brain injuries), and/or serious emotional or psychiatric disturbance (i.e., major depression, psychotic or pervasive developmental disorder) were excluded from the study. ELL children who had been in Canada for fewer than 2 years were not included in the sample. Information on child development, family demographics, and educational and medical history was obtained from parents using a developmental history questionnaire.

Students were classified as ELL if the primary language spoken at home with their parents when they were first learning to speak was a language other than English. This classification is similar to that used in a large Canadian longitudinal study of first and second language learners (Lipka & Siegel, 2007). For most students, this information was obtained through parent questionnaires or parent interviews (83%). Teacher reports (15%) were used to determine language status for students for whom parent questionnaires were not completed. In three cases (2%), language status was obtained by student report. It would be more accurate to describe the group as ESL because they varied in English language abilities; however, to conform to current terminology in the literature, we have retained the ELL term. Overall, English proficiency data were not available to corroborate language status information, and this is recognized as a limitation of the study. Oral language proficiency was measured, however, by the oral language measures and the verbal IQ subtests.

A total of 166 children with RD ranging from 6 years, 11 months, to 13 years, 10 months, at program entry (M = 10.2 years, SD = 1.7 years) participated in this remediation research. A total of 90 students were coded as EFL, and 76 students were coded as ELL. Most of the ELL students were born in Canada or arrived in Canada before school entry (i.e., prekindergarten); all of these children began schooling in mainstream English programs at the same time as the EFL students. Nine different languages were spoken by the present sample of families, with Portugese (N = 37) and Spanish (N = 16) being the most prevalent native languages, and Tagalog (N = 6), Italian (N = 3), Polish (N = 3), Arabic (N = 2), Syrian (N = 1), and Urdu (N = 1) also represented. For seven of the ELL students, native languages could not be reliably established.

This sample included a severely impaired group of children with RD who replicated substantial achievement deficits on the three standardized reading measures. Overall, their average reading performance was between 1½ and 2 *SD*s below age expectations at program entry (WRMT-R Word Attack M standard score = 70.1, SD = 10.9; WRMT-R Word Identification M standard score = 71.4, SD = 12.2; WRAT-3 Reading M standard score = 77.4, SD = 9.9). Overall performance means and SDs for the reading achievement measures are summarized in Table 1 according to language sample (ELL, EFL).

Each participant also completed a brief battery of diagnostic measures before their intervention program; these measures assessed phonological processing and rapid naming skills, receptive vocabulary, and a set of oral language functions. Details of both outcome and diagnostic measures are provided. Diagnostic profiles of the total sample and of the ELL and EFL subsamples are also summarized in Table 1.

Table 1
Characteristics of Participants at Program Entry

	Control				Treatment					
	EFL (n = 28)		ELL (n = 16)		EFL (n = 62)		ELL (n = 60)		Total	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Child's age in years	9.94	1.67	10.41	2.24	10.07	1.46	10.45	1.85	10.22	1.73
WRAT-3 Reading standard score	79.43	9.59	79.25	5.46	77.35	10.03	76.15	11.02	77.45	10.00
WRMT-R Word identification standard score	73.14	11.98	73.00	7.94	72.08	11.84	69.52	13.59	71.42	12.22
WRMT-R Word attack standard score	71.14	9.48	73.13	8.63	69.47	11.22	69.47	11.83	70.10	10.93
WRMT-R Passage Comprehension standard score	72.71	13.97	72.62	9.37	74.31	14.67	71.58	14.13	72.89	13.86
CTOPP Elision standard score	5.82	2.07	6.44	1.86	5.89	1.98	5.82	2.55	5.90	2.2
CTOPP Blending words standard score	8.25	2.19	7.25	2.18	7.47	1.75	7.42	2.44	7.56	2.14
Rapid Automatized Naming Test Numbers—Times	38.21	13.95	39.37	21.03	34.97	12.09	36.09	12.48	36.36	13.57
Rapid Automatized Naming Test Letters—Times	37.45	10.64	40.84	20.72	34.72	11.31	36.15	12.10	36.29	12.66
CELF-3 Concepts and directions standard score	6.73	2.05	5.87	2.17	7.33	2.73	6.48	1.77	6.76	2.26
CELF-3 Word classes standard score	7.35	2.28	6.20	2.08	6.95	2.29	6.45	2.16	6.76	2.23
CELF-3 Formulated sentences standard score	6.00	1.83	5.93	2.50	5.95	2.31	5.31	1.74	5.72	2.06
CELF-3 Recalling sentences standard score	7.31	2.41	6.53	3.09	7.25	2.70	6.11	2.00	6.76	2.49
PPVT-3 Receptive Vocabulary	93.82	13.38	83.00	10.51	90.95	14.06	84.93	11.92	88.48	13.33
WISC-III Verbal IQ	87.89	13.46	80.91	7.49	90.02	11.24	84.30	10.21	86.80	11.29
WISC-III Performance IQ	89.00	16.34	100.36	11.11	97.35	15.03	95.07	12.32	95.50	14.21
WISC-III Full-scale IQ	85.52	13.13	89.87	7.93	91.66	12.43	87.81	9.80	89.03	11.42

Note: CTOPP = Comprehensive Tests of Phonological Processing; WRAT-3 = Wide Range Achievement Test, Third Edition; WRMT-R = Woodcock Reading Mastery Tests–Revised. CELF = Clinical Evaluation of Language Fundamentals; For CELF-3 subtests: Control EFL, n = 26; Control ELL, n = 15; Treatment EFL, n = 57; Treatment ELL, n = 57. PPVT = Peabody Picture Vocabulary Test; For PPVT-3 subtests: Control EFL, n = 28; Control ELL, n = 16; Treatment EFL, n = 60; Treatment ELL, n = 59. WISC = Wechsler Intelligence Scale for Children; For WISC Verbal and Performance IQ: Control EFL, n = 19; Control ELL, n = 11; Treatment EFL, n = 48; Treatment ELL, n = 44. For WISC Full-Scale IQ: Control EFL, n = 27; Control ELL, n = 15; Treatment EFL, n = 58; Treatment ELL, n = 58.

English-language skills were assessed using the Peabody Picture Vocabulary Test–Third Edition (PPVT-3) and four subtests of the Clinical Evaluation of Language Fundamentals–Third Edition (CELF-3; Semel, Wiig, & Secord, 2003), Word Classes, Recalling Sentences, Formulated Sentences, and Concepts and Directions. Phonological skills at entry were assessed on the Elision and Blending Words subtests of the Comprehensive Tests of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) and rapid naming speed was measured using the Rapid Automatized Naming Test (RAN) Letters and Numbers arrays (Wolf & Denckla, 2005). The Wechsler Intelligence Scale for Children–Third Edition (WISC-3) was used to assess intellectual functioning.

A MANOVA was conducted on EFL and ELL status, with scores on the five oral language tests as the dependent measure. Overall, EFL students were different from ELL students on this class of measures ($F(5,139) = 2.57$, $p < .03$). Post hoc univariate contrasts, correcting for multiple comparisons, indicated that the EFL and ELL groups differed on three of the five oral language measures. EFL students were superior in receptive vocabulary (PPVT-3 standard score, $F(1,143) = 11.68$, $p < .001$), and on two of the four CELF-3 subtests (Recalling Sentences standard score, $F(1,143) = 6.19$, $p < .05$; Concepts and Directions standard score, $F(1,143) = 3.80$, $p < .05$), with a trend on the CELF-3 Word Classes subtest, $F(1,143) = 3.12$, $p = .08$. Despite their relative superiority on these language measures, it is important to recognize that the EFL group was below average on all four CELF subtests. On the WISC-3, participants demonstrated overall low average verbal performance (Verbal IQ $M = 86.8$, $SD = 11.3$) and average nonverbal performance IQ ($M = 95.5$, $SD = 14.2$). EFL students scored higher on verbal IQ estimates ($M = 89.3$ for EFL, 83.6 for ELL students), a difference which was significant, $t(120) = 2.91$, $p < .01$. No significant differences between the two samples were revealed on WISC-3 performance IQ or full-scale IQ composites. Both EFL and ELL groups were below average in verbal abilities overall.

The EFL and ELL groups did not differ on the phonological processing and rapid naming measures. Similarly, no significant differences were revealed on any of the reading achievement measures, revealing equivalent levels of underachievement at program entry. No differences were found between the two subsamples when family income demographics for their schools were compared (EFL *M* Family Income percentiles = 3.62, ELL *M* Family Income percentiles = 3.59). Family income data were derived from a Statistics Canada (2001) calculation of average family income across each school's catchment area, based on voluntary reporting on 2004 federal income tax returns.

Research Design

Children who met criteria for inclusion were matched at program entry into groups of four to eight students based on chronological age and on raw scores on word identification and word attack, using the WRMT-R Word Identification and Word Attack subtests and the WRAT-3 Reading subtest. Matching by reading level was done to facilitate grouping according to similar levels of reading skill at entry.

The average difference in age between the youngest and oldest child in a group was 1.51 years ($SD = 0.77$). A few groups included children who spanned a range of 3 years; in every case, an older child was included in the group because he or she was more reading impaired than same-age students, and his or her level of reading skill better matched that of younger students. Groups were randomly assigned to a phonologically based remedial reading program or to a special education curricular control condition. Counterbalancing across program assignment was undertaken to ensure equal representation of grade, reading, and language skills at entry. Students who qualified for participation but did not match other students were placed on a waiting list for participation in a subsequent group.

Children in all conditions received 1 hour of intervention daily, 4 to 5 days per week, for a total of 105 hours of instruction. Treatment outcome testing with all participants occurred before intervention began, after 35 hours, 70 hours, and 105 hours of intervention. All assessments were conducted by qualified testers; all testing occurred at the students' schools.

Intervention and control classes were taught by certified special education teachers in the participants' home schools. Teachers taught at schools in which they were based. These teachers were recommended by school administrators for the program and participated voluntarily. The teachers were trained by Senior Special Education Teachers affiliated with the Learning Disabilities Research Program, and they received 5 full days of off-site training per school year. Two days of initial training occurred before program implementation, and the remaining 3 days occurred during their teaching of the 105-hr program. Three to five additional training and monitoring visits occurred at the teachers' schools (i.e., on-site) during actual program implementation.

Training and monitoring activities included background preparation, classroom observation, direct training instruction, practice, and discussion. Between training sessions, teachers were required to view instructional videotapes, prepare program lessons and materials, practice program activities with other students, participate in program development, establish ongoing cooperative partnerships with other teachers in training, and participate in troubleshooting sessions electronically. Training guidelines were followed by all senior research teachers, including specific methods for delivery of instructional content and a timeline for introducing particular skills. In addition, teacher fidelity to program implementation with every group was checked at least once during each 35-hr teaching block at the school sites.

Reading Intervention Programs

The reading intervention programs provided 105 hours of remedial reading instruction and included a central emphasis on phonologically based word attack and word identification training using the Reading Mastery I/II Fast Cycle or Corrective Reading materials developed by Engelmann and his colleagues at the University of Oregon (Engelmann & Bruner, 1988; Engelmann, Carnine, & Johnson, 1988; Engelmann et al., 1988).

All of the students who qualified for inclusion in the research demonstrated severe underachievement on multiple measures of word identification and word attack. These struggling readers had incomplete letter–sound knowledge and limited decoding skills. The reading interventions of the present study focused on teaching basic word identification and decoding skills, with material ranging in complexity from one-syllable high-frequency words to low-frequency words of five or more syllables. A full range of materials, graduated in difficulty, permitted individualization of instruction according to student needs. Instructional groups were randomly assigned to one of three related remedial reading programs as part of a larger study assessing the efficacy of a combination of different instructional components in the remediation of reading problems. The remedial programs were (a) the PHAST (Phonological and Strategy Training) Decoding Program; (b) the PHAB/DI (Phonological Analysis and Blending/Direct Instruction) Decoding Program, with a spelling and writing component added; and (c) the PHAST Decoding Program with a spelling and writing component added. The PHAST (Lovett, Lacerenza, & Borden, 2000a; Lovett et al., 2000b; Lovett et al., 2005) and PHAB/DI (Lovett, Warren-Chaplin, Ransby, & Borden, 1990; Lovett et al., 2000b) programs have been described in detail in previous publications.

The reading intervention programs all addressed the core deficits in phonological processing and letter–sound knowledge that characterize disabled readers with the goal of facilitating the acquisition of independent decoding skills and acquiring sound–word identification and text reading skills. The programs differed in the addition of explicit instruction in the PHAST word identification strategies and/or in spelling and written instruction. The emphasis in all programs was remediation of basic reading skills and application of new decoding skills to successful passage reading. No explicit reading comprehension instruction was provided in these programs.

The three program variations were associated with significant gains in reading achievement for these struggling readers. Few differences were revealed among the different programs. For purposes of the present article with its focus on individual differences in response to intervention, the three programs are considered together as one research-based remedial reading intervention.

Special Education Curricular Control Condition

The reading intervention programs were compared to a special education curricular control condition. The control group participated in the special education language arts program typically taught in that school's special education classes or resource rooms. These programs were locally developed by schools, eclectic in composition, and included varying proportions of remediation in decoding, phonological awareness, reading comprehension, spelling and/or writing. Control classes offered an equivalent number of hours of remediation and matching teacher–student ratios.

Measures

A full battery of tests was administered to all participants before and after the 105-hr program. An abbreviated test battery was administered at the 35-hr and 70-hr time points. The battery included standardized achievement tests, measures of cognitive abilities, word identification, nonword reading, passage comprehension, visual naming speed and phonological processing, language-based tests, and experimental measures of letter–sound knowledge and transfer of learning in the word identification domain.

Measures of language and cognitive abilities (Dunn & Dunn, 1997). Language skills were assessed at pretest by the PPVT-3 and selected subtests of the CELF-3 (Semel et al., 2003): Word Classes, Recalling Sentences, Formulated Sentences, and Concepts and Directions. Formulated Sentences and Word Classes were repeated with most participants after the 105-hr program. The Wechsler Intelligence Scale for, Children–III (Wechsler, 1997) was used to assess students' cognitive functioning.

Test of visual naming speed. The RAN (Wolf & Denckla, 2005) was administered to participants before the program to assess students' ability to rapidly name visual symbols (letters, colors, objects, and letters).

Phonological processing measures. Selected subtests of the CTOPP (Wagner et al., 1999) were administered at all time-points: (a) Blending Words consists of 20 items and measures the ability to combine orally presented, individual speech sounds into words (e.g., j-u-m-p = "jump"); and (b) Elision is a 20-item test that measures the ability to say what is left of a word after removing designated sounds (e.g., what is the remaining word after removing the "b" sound from "bold" = "old").

Standardized reading measures. Reading outcomes were assessed through standardized measures of academic achievement. The primary outcome measures were the WRMT-R Word Identification, Word Attack, and Passage Comprehension subtests (Woodcock, 1987) to assess change in word identification skills, phonological decoding, and passage comprehension skills, respectively. These subtests were selected as primary outcome measures because they are well standardized, widely used in educational and remedial outcome research, and psychometrically appropriate for human growth-curve modeling. An additional measure of single word identification, WRAT-3 Reading (Blue form), was also used. All of these tests were administered at all time points.

Experimental outcome measures. Two experimental measures assessed acquisition of trained content from the reading interventions; all other experimental measures assessed transfer of learning to uninstructed print materials and tasks. Measures of instructed content assessed word and letter–sound identification accuracy on the following: (a) the Keyword Test, consisting of 120 regular words with high-frequency spelling patterns (Gaskins, Downer, & Gaskins, 1986); (b) the Sound–Symbol Test, a set of 37 letter–sounds presented in isolation, including all single consonant and vowel sounds and selected consonant digraphs (e.g., *th, ch, sh*) and a set of 30 letter–cluster sounds, including vowel digraphs (e.g., *ee, oa*), diphthongs (*oo, oy*), *r*- and *l*-controlled vowels (e.g., *ol, ir*), vowel-controlled consonants (e.g., *ge, gi*), and high-frequency bound morphemes (*ing, tion*). A composite sound–symbol measure was used in the analyses to follow. Both tests were administered at all time points.

The Test of Transfer, administered at all time points, includes 100 words that vary in systematic ways from the 120 keyword spelling patterns taught in the programs: The keyword *bake*, for example, is represented by the transfer probes *fake, babe, bike,* and *baker*, allowing for later analysis of transfer of rime, onset, and letter–sound subsyllabic segments of the trained keyword patterns. This test was selected as a primary outcome measure based on previous research demonstrating that it is psychometrically appropriate for human growth-curve modeling. Previous research has also demonstrated that the Test of Transfer is a more sensitive index than standardized tasks to participants' responsiveness to the various treatment conditions (Lovett et al., 1994; Lovett et al., 2000b; Lovett & Steinbach, 1997; Lovett, Steinbach, & Frijters, 2000c).

The Challenge Words Test, administered at all time points, consists of 105 uninstructed, multisyllabic words that embed the keyword spelling patterns. For example, the keywords *bake* and *grab* are represented in the challenge words *mistakenly* and *uninhabitable*. These words present the child with a difficult decoding task and opportunity for application of newly acquired phonological and/or word identification strategies. Previous investigations revealed this measure to be a sensitive index of training and transfer-of-learning effects in the effective treatment of RD (Lovett et al., 1994; Lovett et al., 2000b; Lovett & Steinbach, 1997).

Further descriptions of these experimental measures and their construction can be found in Lovett et al. (1994), and their psychometric properties have been evaluated and reported in Cirino et al. (2002).

Other measures of academic achievement. Participants' spelling to dictation and computational arithmetic skills were assessed using the WRAT-3 Spelling and Arithmetic subtests, respectively.

Results

Model Fitting

Model fitting followed guidelines found in Snijders and Singer (Singer & Willet, 2003; Snijders & Bosker, 1999), generally fitting the random portion of the model initially, incorporating fixed effects and refitting and respecifying the entire model as justified empirically and theoretically. A common set of fixed effects was formulated prior to model fitting, described below, and these were incorporated into the prediction of individual ability and response to remediation. Assessment points were equally spaced every 35 hours of instruction, simplifying the Level 1 model for intraindividual change to the following:

$$\gamma_{ij} = \pi_{0i} + \pi_{1i} TIME + \varepsilon_{ij}.$$

Level 2 or interindividual predictors were incorporated into this model after appropriate centering or coding (for categorical predictors) according to the following model. ELL (status as an English language learner) and LANGUAGE (PPVT-3) are exemplar categorical and continuous predictors:

$$\pi_{0i} = \gamma_{00} + \gamma_{01}ELL + \gamma_{02}LANGUAGE + \zeta_{0i}$$
$$\pi_{1i} = \gamma_{10} + \gamma_{11}ELL + \gamma_{12}LANGUAGE + \zeta_{1i}.$$

The final composite model integrated Level 1 and Level 2 parameterization, including cross-level interactions between individual difference factors and intraindividual growth.

Random Effects

Unconditional growth models were formed after graphical examination of raw outcome data over time for individual children. This qualitative look at students' growth curves indicated that reading and reading-related skills grew monotonically for all outcomes, with an apparent curvilinear component for experimental measures of word identification learning and transfer of learning (e.g., Sound Combinations, Test of Transfer). In these cases, skill growth was rapid early in the program, leveling off somewhat in latter portions. Model fit comparisons (–2 log likelihood) of random intercept models with or without a random curvilinear component for these measures supported a nonlinear growth trajectory. Time was modeled according to the four program testing points and centered at program end. For all curvilinear growth models, both fixed and random quadratic terms were added, with time in program centered at 52 hours of instruction or approximately half way through the program. For the models incorporating a curvilinear component, linear growth reflects the instantaneous rate of change at 52 hours of instruction. Overall, substantial variability in final status and growth rates was observed across all outcome measures, indicating that individual variation in these random variance components might be explained by individual difference predictors. Tables 2 and 3 detail both null and random effects models for all outcomes.

The growth models were initially formulated as three-level hierarchical models, with observations nested within children and then within their teacher. For all but two outcome measures, significant variability from teacher to teacher was noted only on their children's initial status. On two program-instructed outcomes (e.g., Sound Symbol and Keyword tests), significant variability was noted in growth rates. However, when three-level models for these outcomes were formulated with individual difference and group predictors, neither fixed coefficients nor their standard errors were appreciably changed in comparison to the simpler two-level models. This suggests that although teachers varied in their effectiveness in terms of students' acquisition of program material, such variability was not related to the program, language status, or individual difference predictors that are central to the present analysis. In light of this and in the interest of parsimony, two-level hierarchical models were formulated for all outcomes (i.e., observations nested within children).

Fixed Effects and Individual Difference Predictors

To answer the substantive questions of the present analysis, a common set of individual difference predictors were incorporated into each model of skill growth. Program status was indicated via two a priori and orthogonal contrasts as follows: (a) Students receiving a research-based reading program (treatment) compared to those in the special education curricular control condition and (b) for students participating in treatment, EFL compared with ELL. The following individual difference predictors were also included as fixed effects in each model: (a) grand-mean centered age of student at program entry; (b) RAN speed; (c) phonological awareness; and (d) language ability. A Principal Components Analysis with varimax rotation was used to create the phonological and RAN composite scores. The CTOPP Elision and Blending subscales along with RAN letters and numbers formed two factors, accounting for 82.6% of the variance in these measures, with no cross-loadings above .20. The RAN times were converted to speeds by taking the reciprocal of both RAN numbers and letters. This transformation improved both univariate normality and the principal components solution. In the analyses to follow, higher RAN scores on this factor-derived composite indicate greater naming speed or faster performance on the RAN naming arrays. Similarly, a simple language composite was formed from the raw scores of four CELF subscales (Concepts and Directions, Word Classes, Formulated Sentences, Recalling Sentences). The resulting set of five individual difference predictors was sufficiently concise to maintain a favorable case-to-variable ratio with each of the EFL and ELL subgroups for the fixed predictors. The close theoretical relationship between EFL and ELL status and language ability and differences in pretest language levels between these two groups suggested that higher order interactions may be present in the data. Interaction terms between EFL and ELL status and language ability were also incorporated into each full model. Where these higher order

Table 2
Growth Curve Model Results for Experimental Measures of Learning and Transfer of Learning Prior to Inclusion of Individual Difference Predictors

Fixed Effects		Parameter	Sound Symbol	Keyword Test	Test of Transfer	Challenge Test
Final status	Intercept	γ_{00}	51.08***	105.07***	65.03***	40.34***
Rate of change	Intercept	γ_{10}	4.32***	8.07***	8.77***	7.83***
Acceleration	Intercept	γ_{20}	–1.33***	–1.50***	–1.09***	
Variance components						
Level 1	Within person	σ^2_{ε}	8.04***	18.97***	22.67***	32.73***
Level 2	In initial status	σ^2_{0}	60.67***	499.55***	690.54***	617.52***
	In rate of change	σ^2_{1}	4.94***	49.34***	25.90***	17.88***
	In acceleration	σ^2_{2}	1.50***	4.14***	2.69**	
Correlations	Final status with rate	σ^2_{01}	0.24	0.02	0.04	0.43
	Final status with acceleration	σ^2_{02}	–0.25	0.03	0.05	
	Acceleration with rate	σ^2_{12}	0.25	0.19	0.13	

** $p < .01$. *** $p < .001$.

Table 3
Growth Curve Model Results for Standardized Tests of Phonological Processing and Reading Skill Prior to Inclusion of Individual Difference Predictors

Fixed Effects		Parameter	CTOPP Blending (Raw)	WRAT-3 Reading (Standard Score)	WRMT-R Word Identification (Standard Score)	WRMT-R Word Attack (Standard Score)	WRMT-R Passage Comprehension (Standard Score)
Final status	Intercept	γ_{00}	12.83***	83.93***	76.69***	79.39***	78.62***
Rate of change	Intercept	γ_{10}	1.03***	1.94***	1.62***	5.87***	1.66***
Variance components							
Level 1	Within person	σ^2_{ε}	2.70***	24.17***	10.64***	22.87***	19.50***
Level 2	In initial status	σ^2_{0}	9.56***	100.25***	145.46***	100.20***	176.03***
	In rate of change	σ^2_{1}	0.44***	0.59	2.69***	5.87***	6.16***
Correlations	Final status with rate	σ^2_{01}	0.28	0.26	0.13	0.42	0.19

Note: CTOPP = Comprehensive Tests of Phonological Processing; WRAT-3 = Wide Range Achievement Test, Third Edition; WRMT-R = Woodcock Reading Mastery Tests–Revised.
*** $p < .001$.

interactions were not significant, they were removed from the model to maintain a parsimonious solution (Snijders & Bosker, 1999).

Final models, incorporating random and fixed terms, are detailed in Tables 4 and 5. Results from analyses of the experimental measures are summarized first.

Outcomes on Experimental Measures of Learning and Transfer of Learning

On all experimental measures, significant and substantial fixed effects were revealed for intervention condition. Instruction in the research-based reading interventions affected both final outcomes and rate of change over the 105 hours for these children with reading disability. Children who had received intervention were superior at posttest on all measures of instructed content and all measures of transfer of learning to children who had received an equivalent amount of special education reading remediation. On the Test of Transfer, for example, children in the intervention condition scored substantially higher at posttest (M = 69.5/100) than children in the special education control condition (M = 55.2/100; contrast coefficient = 7.13, SE = 2.22, $t(157) = 3.21$, $p < .01$). Intervention children also demonstrated greater growth over the intervention period. On the same outcome measure, the Test of Transfer, intervention children increased their accuracy by 12.1 words at each testing point, whereas control children improved by only 5.0 words per testing point ($t(467) = 6.69$, $p < .001$).

In contrast, no significant fixed effects were found for EFL and ELL status when final outcomes were modeled.

Table 4
Growth Curve Model Results for Experimental Measures of Learning and Transfer of Learning

Fixed Effects		Parameter	Sound Symbol	Keyword Test	Test of Transfer	Challenge Test
Final status	Intercept	γ_{00}	49.92***	102.70***	62.37***	37.77***
	Treatment vs. Control	γ_{01}	7.83***	9.57***	7.13**	5.69**
	EFL vs. ELL	γ_{02}	–0.58	–1.18	–0.60	–0.72
	Age	γ_{03}	0.46	0.54	0.61	1.61
	Rapid Automatized Naming	γ_{04}	0.77	9.29***	12.20***	10.21***
	Phonological Awareness	γ_{05}	3.04***	5.96**	9.79***	9.63***
	Language Ability	γ_{06}	1.10	3.38	3.69	5.55*
Rate of change	Intercept	γ_{10}	4.17***	8.14***	8.55***	7.42***
	Treatment vs. Control	γ_{11}	2.28***	3.13***	3.54***	2.70***
	EFL vs. ELL	γ_{12}	0.11	–1.18*	–0.42	–0.42
	Age	γ_{13}	0.15	–0.95**	–1.39***	–0.99***
	Rapid Automatized Naming	γ_{14}	–0.17	–1.56**	0.65	1.80 ***
	Phonological Awareness	γ_{15}	–0.61**	–1.37*	–0.68	1.30**
	Language Ability	γ_{16}	–0.32	–1.22†	0.41	1.02*
	Language × Treatment vs. Control	γ_{17}		–1.33†	–1.62*	–1.20**
	Language × EFL vs. ELL	γ_{18}		0.70	–0.37	–0.66*
Acceleration	Intercept	γ_{20}	–1.24***	–1.40***	–1.00***	
	Treatment vs. Control	γ_{21}	–0.75***	–0.85*	–0.88**	
	EFL vs. ELL	γ_{22}	–0.01	0.24	0.27	
Variance components						
Level 1	Within person	σ^2_ε	8.08***	19.09***	22.60***	32.92***
Level 2	In initial status	σ^2_0	18.48***	280.15***	330.08***	241.85***
	In rate of change	σ^2_1	2.07***	23.81***	14.73***	9.54***
	In acceleration	σ^2_2	1.26**	3.79***	2.30*	
Correlations	Final status with rate	σ^2_{01}	0.28	0.03	0.19	0.47
	Final status with acceleration	σ^2_{02}	–0.25	0.05	0.06	
	Acceleration with rate	σ^2_{12}	0.27	0.22	0.16	
Pseudo R^2	Group vs. null growth for initial status		.44	.09	.04	.03
	Group vs. null growth for rate of change		.48	.10	.20	.18
	All predictors vs. null growth for initial status		.70	.44	.52	.61
	All predictors vs. null growth for rate of change		.58	.52	.43	.47

Note: EFL = English as a first language; ELL = English-language learner; Pseudo R^2 is calculated from Level 2 variance components as per Snijders & Bosker, 1999.
$^\dagger p < .10$. $^* p < .05$. $^{**} p < .01$. $^{***} p < .001$.

EFL and ELL participants demonstrated equivalent outcomes following intervention or control instruction and demonstrated equivalent rates of change over time. Intervention was associated with the same posttest advantage for EFL (*M* Test of Transfer score = 61.8/100) and ELL students (*M* = 63.0/100). Similarly, growth during the intervention period was parallel for the two subsamples, the EFL students gaining on average 8.1 words per testing point and the ELL students an average of 9.0 words. There was one exception to this pattern of results for EFL and ELL status. EFL and ELL status was associated with differing rates of growth on the Keyword Test, the ELL students showing greater linear growth in their acquisition of the keywords over time than the EFL students, $t(457) = –2.40$, $p < .02$.

The effects for the treatment and control and the EFL and ELL comparisons are summarized in Figure 1, again using the Test of Transfer outcomes as representative of this class of outcome measures. Figure 1 presents the mean number of Test of Transfer words correctly identified at each testing point. The values represented in the graph are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth.

Of the individual differences predictors, substantial fixed effects were revealed for initial phonological awareness and rapid naming speed, with effects revealed on final outcomes and on rate of growth. Level of phonological skill at entry affected outcomes on all experimental reading and sound–symbol measures, and

Table 5
Growth Curve Model Results for Standardized Tests of Phonological Processing and Reading Skill

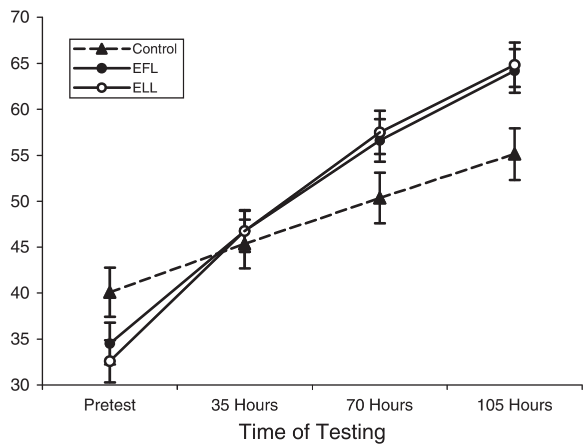
Fixed Effects		Parameter	CTOPP Blending (Raw)	WRAT-III Reading (Standard Score)	WRMT-R Word Identification (Standard Score)	WRMT-R Word Attack (Standard Score)	WRMT-R Passage Comprehension (Standard Score)
Final status	Intercept	γ_{00}	12.55***	83.29***	76.10***	78.58***	77.87***
	Treatment vs. Control	γ_{01}	0.87**	3.06**	0.76	3.61**	0.15
	EFL vs. ELL	γ_{02}	–0.49*	–1.53*	–0.74	–2.11*	–0.81
	Age	γ_{03}	–0.29	–4.54***	–4.69***	–2.84***	–4.72***
	Rapid Automatized Naming	γ_{04}	0.26	5.28***	7.23***	4.06***	5.18***
	Phonological Awareness	γ_{05}	1.78***	4.13***	4.73***	4.78***	2.60*
	Language Ability	γ_{06}	0.93*	2.68*	1.94	1.65	7.53***
Rate of change	Intercept	γ_{10}	1.02***	1.83***	1.44***	2.43***	1.66***
	Treatment vs. Control	γ_{11}	0.34**	1.42***	0.95***	1.42***	0.10
	EFL vs. ELL	γ_{12}	–0.19*	–0.28	–0.27	–0.39	–0.25
	Age	γ_{13}	–0.08	–0.20	0.06	0.28	0.10
	Rapid Automatized Naming	γ_{14}	0.15	0.14	–0.24	–0.28	–0.50
	Phonological Awareness	γ_{15}	–0.34***	0.03	0.60**	–0.48	–0.83*
	Language Ability	γ_{16}	0.08	0.10	0.26	0.55	0.69
	Language × Treatment vs. Control	γ_{17}	0.20*				
	Language × EFL vs. ELL	γ_{18}	–0.05				
Variance components							
Level 1	Within person	σ^2_ε	2.70***	23.51***	10.73***	22.86***	19.47***
Level 2	In initial status	σ^2_0	5.63***	50.13	91.04***	64.53***	122.70***
	In rate of change	σ^2_1	0.26**		1.47**	4.44***	5.66***
Correlations	Final status with rate	σ^2_{01}	0.63		0.13	0.42	0.33
Pseudo R^2	Group vs. null growth model for initial status		.04	.03	.00	.07	.00
	Group vs. null growth model for rate of change		.20		.18	.17	.01
	All predictors vs. null growth for initial status		.41	.50	.37	.36	.30
	All predictors vs. null growth for rate of change		.41		.45	.24	.08

Note: EFL = English as a first language; ELL = English-language learner; CTOPP = Comprehensive Tests of Phonological Processing; WRAT-3 = Wide Range Achievement Test, Third Edition; WRMT-R = Woodcock Reading Mastery Tests–Revised; Pseudo R^2 is calculated from Level 2 variance components as per Snijders, 1999.
$*p < .05$. $**p < .01$. $***p < .001$.

naming speed affected outcomes on the keywords, Test of Transfer, and challenge words measures. Generally, children with relatively stronger phonological skills and naming speed were at an advantage in posttest performance on these outcome measures. Phonological awareness at entry also affected rate of change on the Sound–Symbol, Keywords, and Challenge tests. The pattern of the relationship differed on these measures, however; on the sound–symbol and keyword measures, students with the weakest phonological skills showed greater growth at each testing point, whereas on the challenge words, children with relatively stronger phonological skills demonstrated superior growth at each testing point. Rapid naming at entry affected rate of change on the keywords and challenge words measures, reflecting the same pattern as found for phonological skill as an individual differences predictor. On the keyword measure, children with the slowest naming speeds demonstrated greater growth at each testing point, $t(457) = –3.13$, $p < .01$, whereas on the challenge words, the opposite pattern was revealed, with the relatively faster students showing greater growth, $t(471) = 4.19$, $p < .001$.

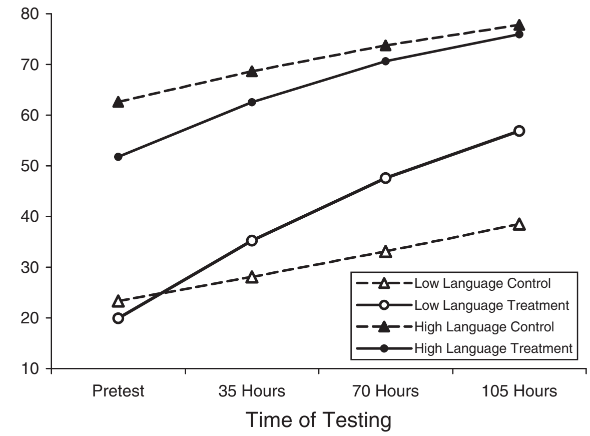
Language abilities at entry also influenced final outcomes on the Challenge Test, $t(157) = 2.35$, $p < .02$. Relatively stronger language students could identify a greater number of challenge words at posttest ($M = 43.3$) than lower language students could ($M = 32.2$ words). Initial language ability exerted a substantial influence on

Figure 1
Mean Number of Test of Transfer Words at Each Testing Point, by Treatment Group



Note: Values represented are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. Growth rate and final status of students in the treatment groups (n = 122) were both significantly greater than that of curricular control (n = 44) students.

Figure 2
Mean Number of Test of Transfer Words at Each Testing Point, by Treatment Status and Language Ability



Note: Values represented are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. Treatment (n = 122) and control (n = 44) include EFL and ELL students combined, with low and high language ability groups determined via a median split of pretest scores on the Clinical Evaluation of Language Fundamentals, 3rd edition, the four subtests described previously.

rate of growth on the keyword, transfer, and challenge word measures, interacting with intervention condition on all three, but with EFL and ELL status only on the challenge words.

The impact of language ability in predicting growth on the Test of Transfer measure is illustrated by the graph presented in Figure 2. The mean number of correctly identified words at each testing point is presented for higher language and lower language students for both the intervention and the control conditions. The values represented in the graph are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. The intervention or treatment (n = 122) and control (n = 44) conditions include EFL and ELL students combined, with low and high language ability groups determined via a median split of pretest scores on the CELF-3, the four subtests described previously. When instructed in the research-based reading interventions, children with lower language abilities at entry demonstrated the steepest rate of growth over the intervention period. This fixed effect for the interaction of initial language ability and intervention condition demonstrates the impact of the intervention on the rate at which students with the lowest levels of language skill can profit from remediation of this type. Lower language children in the intervention classes grew at an average rate of 12.3 words per testing point, whereas higher language children grew only by 8.1 words per testing point. It should be recalled that the entire sample was below average on verbal and oral language skills and that, therefore, the lower language participants represented in the median split were particularly language impaired. The interaction between language ability and EFL and ELL status on challenge words growth could be attributed to somewhat steeper linear growth for higher language ELL students and lower language EFL students.

Acceleration effects were revealed for the first three outcome measures, indicating a curvilinear component to growth. Acceleration interacted with intervention condition on the sound–symbol composite, $t(458) = –3.45$, $p < .01$; keywords, $t(457) = –2.43$, $p < .02$; and the Test of Transfer, $t(467) = –2.60$, $p < .01$. The negative coefficients for these acceleration interactions indicate that acceleration was fastest in the intervention conditions in the first sections of the program. No fixed effects were revealed for acceleration in modeling growth on the challenge words, indicating that average growth on this outcome measure was best captured as linear growth.

Outcomes on Standardized Tests of Phonological Processing and Reading Skill

Outcomes on five standardized measures were assessed, including three WRMT-R subtests (Word Attack, Word Identification, Passage Comprehension), WRAT Reading, and the CTOPP Blending Words subtest. Fixed effects for intervention condition were revealed for all measures except Passage Comprehension. Children who had received the research-based interventions were superior at posttest on standardized measures of word attack, phonological processing, and word reading, and demonstrated steeper rates of growth in these skill domains over the intervention period than did the special education control participants. On the Word Identification subtest, intervention condition was associated with substantial and significant fixed effects for growth but not for final outcomes; the latter negative result appeared due to higher than expected pretest values for control group participants on this measure.

Fixed effects for EFL and ELL status were revealed on two measures: the CTOPP Blending Words and the WRAT Reading measures. In Blending Words, the ELL students grew faster, $t(458) = –2.16$, $p < .03$, and ended up marginally better than the EFL students at posttest, $t(157) = –1.87$, $p = .06$. On the WRAT Reading subtest, ELL students again demonstrated superiority on this outcome measure at posttest, $t(157) = –1.97$, $p < .05$. In both cases, the differences were reliable but not substantial in magnitude.

Of the individual differences predictors, substantial fixed effects were revealed for initial phonological status and naming speed in influencing outcomes on all the standardized reading measures: word attack, word identification, WRAT Reading, and passage comprehension. In each case, positive coefficients reveal that children who were relatively stronger in phonological processing skill and naming speed at entry ended the intervention period with superior reading achievement in every dimension of reading skill tested. Initial phonological skills also predicted rate of growth on the word identification and passage comprehension measures. On word identification, children with relatively better phonological skills demonstrated greater growth over time, $t(464) = 2.81$, $p <.01$; on the passage comprehension measure, children with weaker phonological skills demonstrated greater growth, $t(471) = –2.41$, $p < .02$. Initial language status influenced outcomes on the WRAT Reading, $t(157) = 2.25$, $p < .03$, and passage comprehension measures, $t(157) = 4.43$, $p < .0001$, with children with relatively stronger language skills achieving superior outcomes on these measures. The effect was clear on the passage comprehension measure, where higher language children scored on average a standard score of 85.4 after intervention and lower language children scored on average 70.3, a full *SD* apart.

On the phonological processing outcome measure, the CTOPP Blending Words subtest, phonological and language status influenced outcomes in this domain, with relatively stronger children achieving better outcomes at posttest. Phonological skills also predicted growth, with relatively weaker children demonstrating faster growth over time. Language status interacted with intervention condition in predicting growth, $t(458) = 2.34$, $p < .02$. Children with relatively higher language skills demonstrated a greater intervention advantage over higher language participants in the control group, a more robust effect than with lower language intervention and control students. No interactions were revealed between language status and EFL and ELL status.

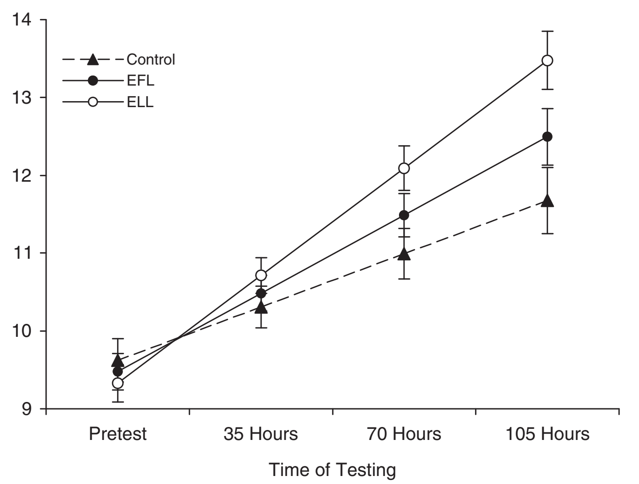
Figures 3 and 4 summarize results on the CTOPP Blending Words and the WRMT-R Word Attack subtest. In Figure 3, mean number of items correct on the CTOPP Blending Words subtest is represented for each testing point. Values represented are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. Growth rate and final status of students in the treatment groups were both significantly greater than that of the special education control students. Growth rate of ELL students ($n = 60$) was significantly greater than EFL ($n = 62$) students, $t(478) = 2.16$, $p < .05$, with the final status of ELL students marginally higher than for EFL students, $t(157) = 1.87$, $p = .06$.

In Figure 4, mean standard scores on the WRMT-R Word Attack subtest are presented for each testing point. Values represented are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. Growth rate, $t(473) = 3.94$, $p < .001$, and final status, $t(157) = 3.37$, $p < .01$, of students in the treatment groups ($n = 122$) were both significantly greater than that of curricular control students ($n = 44$). Although final status of ELL students ($n = 60$) was significantly greater than for EFL students ($n = 62$), $t(157) = 2.48$, $p < .01$, growth rates did not significantly differ, $t(473) = 1.36$, $p = .17$.

Post Hoc Analysis of Outcomes for Participants With Lower IQs

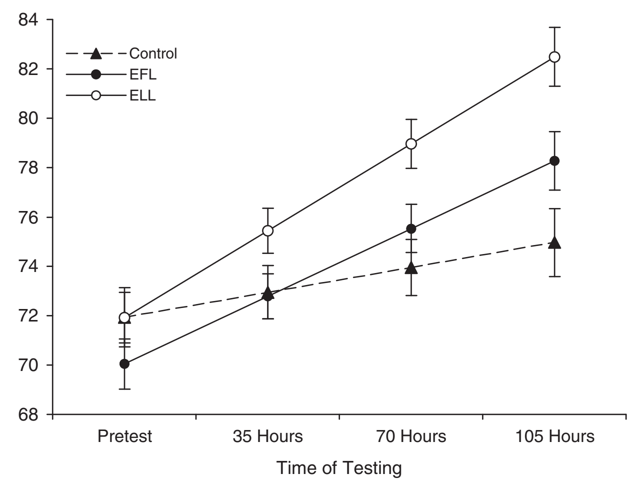
The full sample used in the present growth curve analyses included all children who participated in either the treatment or special education control conditions, including those children with full-scale IQ scores on the WISC of less than 85. To investigate whether the lower IQ participants constituted a qualitatively distinct subsample and to justify their inclusion in the overall analyses, a 3 (ELL, EFL, Control) × 2 ($IQ < 85$, $IQ \geq 85$) × 4 (Time of testing) mixed repeated measures ANOVA was conducted. Across all study outcome measures, no three-way interactions were present that would indicate potential differential response to treatment according to IQ

Figure 3
Mean Number of Items on the Comprehensive Tests of Phonological Processing Blending Words Subtest at Each Testing Point



Note: Values represented are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. Growth rate and final status of students in the treatment groups were both significantly greater than that of curricular control students. Growth rate of ELL students (n = 60) was significantly greater than EFL (n = 62) students, with the final status of ELL students marginally higher than EFL students.

Figure 4
Mean Standard Scores on the Woodcock Reading Mastery Test—Revised Word Attack Subtest at Each Testing Point



Note: Values represented are growth model–derived means and standard errors, incorporating all fixed effects and adjusting for random effects modeling growth. Growth rate and final status of students in the treatment groups (n = 122) were both significantly greater than that of curricular control students (n = 44). Although final status of ELL students (n = 60) was significantly greater than EFL students (n = 62), growth rates did not significantly differ.

status. As illustrated in Figure 5, using the Test of Transfer as a representative measure, treatment group by time effects were observed (i.e., differential slopes for ELL, EFL and Control children, $F(6,492) = 11.14$, $p < .001$, $\eta^2 = .12$), but there were neither differential slopes according to IQ level (i.e., lower IQ and higher IQ children responded equally well to the remedial programs, $F(3,492) = 0.39$, $p = .76$, $\eta^2 = .00$), nor a three-way interaction, $F(6,492) = 0.47$, $p = .47$, $\eta^2 = .01$.

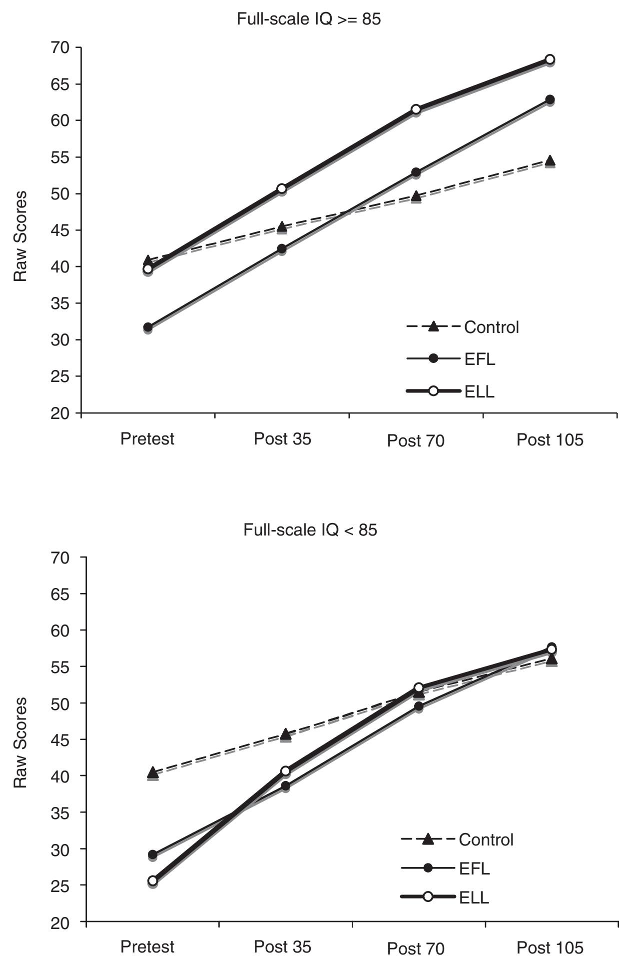
Discussion

These data provide evidence of the efficacy of the present phonologically based interventions relative to equivalent time and attention in the special education control condition. On all outcome measures but one, children who had received the research intervention outperformed their peers who received an equivalent amount of special education reading remediation, and these children demonstrated greater rates of growth over time in their reading and reading-related skills. These effects were substantial and significant for all experimental measures of learning and transfer of learning and were confirmed on the majority of standardized reading achievement measures, with the exception of WRMT-R Passage Comprehension.

No overall differences were revealed for children of EFL versus ELL status when their response to intervention and their growth over the intervention period was compared. EFL and ELL struggling readers demonstrated equivalent outcomes in both the intervention and the control conditions and demonstrated essentially parallel rates of change over time. These data suggest that the same principles of systematic and explicit phonologically based intervention are effective for struggling readers irrespective of primary language status, as long as a basic level of English-language competence had been achieved. ELL students in the present sample attained an overall standard score of 84.5 on the PPVT-3 (SD = 11.6), an estimate of receptive vocabulary, and all were enrolled in English-language schools.

In considering the equivalent response to intervention by EFL and ELL struggling readers, it is important to recall that the present ELL participants may be more aptly described as ESL. Struggling readers were designated according to their primary language influence in the home, English or a language other than English. At

Figure 5
Mean Raw Scores on the Test of Transfer, Across English-Language Learners, English as a First Language, and Control Children



Note: The first graph for children with full-scale IQ greater than or equal to 85 and the second graph for children with IQ less than 85.

the same time, it is recognized that the ELL students were consistently inferior to the EFL students on verbal and language measures, despite the fact that the EFL students were themselves quite low in language ability. This difference in oral language performance is replicated across several measures and occurs in the context equivalent levels of RD.

These data evaluating response to intervention by disabled readers of differing primary language status are compatible with evidence from studies comparing the reading acquisition of EFL and ELL children. Geva and her colleagues (Geva & Yaghoub-Zadeh, 2006; Geva et al., 2000) have demonstrated that similar levels of early reading skill and word and text reading efficiency can be achieved despite differences in oral language status. It has been noted that learning to read in a second language need not be considered a risk factor for RD (Lipka et al., 2005).

Evidence on the early phonological processing skills of EFL and ELL beginning readers has been more equivocal. Some studies have reported equivalent levels of phonological performance for ELL children in the Kindergarten through Grade 2 range (Chiappe, Siegel, & Wade-Wolley, 2002; Lipka et al., 2005), whereas others have found that ELL children of the same ages lag behind their EFL peers in developing phonological processing skills (Lipka & Siegel, 2007). In the present study, ELL struggling readers were not overall inferior to their EFL counterparts on two dimensions of phonological skill: elision and blending.

Growth in phonological processing skill over the course of remediation did differ, however, for children of EFL versus ELL status. The struggling readers who were ELL grew faster and were marginally better at posttest in blending words skill than were the EFL struggling readers. The same posttest advantage for ELL students was observed on the WRAT-3 Reading outcomes. ELL students demonstrated superior WRAT-3 Reading standard scores after remediation than did EFL students, although the difference was not sizeable (ELL $M = 84.8$; EFL $M = 81.8$). On all other outcome measures, EFL and ELL struggling readers demonstrated equivalent posttest performance and rates of growth.

An important source of individual differences in intervention outcomes concerned the influence of English oral language abilities in general, irrespective of primary language status. Oral language skills were highly predictive of final status on the WRMT-R Passage Comprehension measure, with higher and lower language children a full SD apart in passage comprehension outcomes (higher language M standard score = 85.4, lower language M standard score = 70.3). Similar results were observed for challenge words outcomes and for the WRAT-3 Reading and CTOPP Blending Words outcomes.

Of greater interest is the finding that English oral language abilities at entry interacted with intervention condition in predicting reading growth over the duration of intervention. This finding is relevant in identifying treatment-specific effects for the present phonologically based interventions. On two of the most sensitive experimental outcome measures, the Test of Transfer and Challenge Words, initial oral language abilities reliably predicted amount of growth in the research-based intervention programs. Generally, lower language ability children grew at a faster rate than their higher language–ability peers in the intervention programs. It appears that the structured format and opportunities for overlearning and consolidation in the phonologically based intervention programs allowed the most language-impaired struggling readers to make greater progress relative to their peers.

It must be emphasized that the present sample of disabled readers is a sample of children with significant language impairment. Although the EFL students were stronger than the ELL students on the majority of oral language measures, the EFL participants were themselves significantly below age level expectations on all of the CELF subtests. Both subsamples demonstrated below average verbal and oral language functioning overall.

It has been reported that oral language ability in ELL students may not be a reliable predictor of reading acquisition success (Geva & Yaghoub-Zadeh, 2006), although its predictive value may vary at different stages of reading development and for different native languages (Manis, Lindsey, & Bailey, 2004). Language impairment, however, appears to be a very important factor in moderating response to remediation of this type. The co-occurrence of reading problems and oral language deficits is well recognized (Bishop & Snowling, 2004). Researchers from Australia reported that more than 50% of their sample of children with specific reading disorder also exhibited significant deficits in oral language development, scoring more than 1 SD below expectation on the CELF-3 (McArthur, Hogben, Edwards, Heath, & Mengler, 2000).

It is thus not surprising that equally high rates of reading acquisition problems are seen in samples of children with specific language impairment. Longitudinal studies of children diagnosed with preschool language impairment have identified significant underachievement in word identification and reading comprehension skills in the elementary grades (Bishop & Adams, 1990; Catts, Fey, Tomblin, & Zhang, 2002), as well as persisting problems well into adolescence (Snowling, Bishop, & Stothard, 2000; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). Children whose language problems had been successfully treated fare better than children whose language problems persist (Catts et al., 2002), although they too tend to be inferior compared to more able language learners in later reading performance.

Recent research has emphasized the synergy that characterizes development of oral and written language systems from the primary grades on (Stone, Silliman, Ehren, & Apel, 2004), drawing attention to the metalinguistic awareness of morphology and the depth of vocabulary knowledge needed in successful reading development (Carlisle, 2004; McGregor, 2004). Snowling and her colleagues (Bishop & Snowling, 2004; Snowling et al., 2000) documented the course of reading development and reading dysfunction in a longitudinal sample of children with specific language impairment at the preschool level, comparing the achievement of resolved versus persisting specific language impairment. From their results, they caution against simplistic models of reading development, emphasizing the importance of recognizing reading as a "dynamic system" with "multicausal development." From the present intervention data, we can specify that language impairment moderates response to the phonologically based remediation, but with the wide age range represented in the sample, it is impossible to describe in detail the changing role of that moderating influence at different stages of reading development.

On a cautionary note, it should be recognized that the present EFL and ELL samples might differ in the types of struggling readers they include. The EFL sample likely includes a greater number of children who demonstrate more typical RD profiles. Although the English-language proficiency of the EFL struggling readers is overall superior to that of their peers, they do exhibit a profile of depressed verbal and oral language skills relative to age-appropriate standards on measures of primary language function. It is difficult to distinguish in the profiles of the ELL struggling readers, however, whether depressed performance on the verbal and language measures reflects true weakness in oral language processing or limited proficiency with the English language. Inclusion of oral language measures in the ELL child's native language would be needed to more accurately characterize their language processing skills.

When the roles of initial phonological status and naming speed were assessed, a somewhat similar pattern was revealed as with level of language impairment. Both phonological skill and naming speed were highly significant predictors of final outcomes on nearly all experimental and standardized reading outcomes. As seen before, higher pretest performance was associated with higher levels of reading achievement at the end of intervention. Phonological skill played a more substantial role than naming speed in predicting rate of growth over time. The predictive pattern varied, however, according to the outcome studied. On measures of blending words, letter–sound knowledge, keyword identification, and passage comprehension, greater growth over the intervention period was revealed for children with lower phonological skills at entry. On the more difficult word identification measures, however—challenge words and word identification—children with better phonological skills demonstrated greater growth. This latter finding is contrary to the findings on challenge word growth as a function of overall language ability, in which lower language children grew more over time.

The present sample included some lower IQ participants, lower than traditionally included in RD samples.

When the sample was subdivided according to IQ status in a post hoc analysis, however, there were neither differential slopes nor different outcomes according to IQ level; lower IQ and higher IQ children responded equally well to the remedial programs. These results replicate our previous findings examining the remedial response of young children with RD to similar interventions (Morris et al., submitted). In that study, a factorial evaluation of the influence of IQ and other demographic factors was undertaken. IQ did not interact with slope on any of the major outcome measures, confirming that both the lower and the higher IQ groups demonstrated equivalent rates of growth over the course of intervention and in the year following intervention.

One of the strengths of the present design was the inclusion of a special education control condition. Groups of children with RD were randomly assigned to either a research-based intervention program or to an active treatment control intervention that provided equivalent instructional time, active reading remediation, and the same teacher–student ratio. Inclusion of this control condition allows intervention effects to be better attributed to program-specific features of the research-based intervention rather than to the benefits of individualized attention and reading remediation per se.

Another strength of the present design was the measurement of multiple dimensions of reading growth and the use of a range of experimental and standardized reading outcomes. Outcomes are essentially as multidimensional and dynamic phenomena as the reading process itself. The importance of assessing multiple components of reading skill development is suggested by the somewhat different pattern of results found on different measures. As one example, the sensitivity and specificity of challenge words as an outcome measure is implied in these findings and those of other intervention studies conducted by our group (Lovett et al., 1994, 2000b; Morris et al., submitted). The demands and differing patterns of growth on the challenge words measure is suggested by the fact that it is the only outcome characterized by linear rather than curvilinear growth and its growth is predicted differentially by individual differences at program entry.

There are also limitations to the present design. The research-based interventions were consistently phonologically based but varied in the extra components added to that base. The efficacy of these components for struggling readers of different primary language status, therefore, could not be evaluated in the present article. Similarly, although the special education control was a strength, no specification of the different approaches used in these special education settings was available. Finally, the ELL sample was varied in terms of primary language status and so the interaction between primary and secondary language influences could not be addressed.

Despite these limitations, these findings add to the literature on the efficacy of reading remediation for struggling readers of differing primary language status. The present results confirm the value of systematic and explicit phonological reading remediation for children of EFL or ELL backgrounds who are significantly delayed in reading development. Response to remediation and rate of growth during remediation were equivalent for struggling readers irrespective of primary language status. Rather than primary language, it was level of language impairment that emerged as a highly significant predictor of reading outcomes, particularly on more complex measures of reading achievement (e.g., challenge words, passage comprehension). In the domain of passage comprehension, for example, less language-impaired children scored a full SD better than their more language-impaired peers after 105 hours of intervention. In predicting rate of improvement, level of language impairment also played a substantive role, with the most impaired children demonstrating greater rates of growth with intervention. The latter result is encouraging in supporting efforts to provide systematic research-based remediation to children whose acquisition of language in both spoken and written form is severely impaired.

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