PART IV
Strategies for Remediation

The papers in this section explore multiple strategies for remediation of reading difficulties. The literature reviews are current, the techniques sophisticated, and the respect for empirical evidence outweighs (as it must) adherence to a particular philosophy of instruction.

In chapter 9, Sylvia Abbott and Virginia Berninger present a detailed curriculum for students in grades 4 to 7, contrasting two different ways to provide explicit instruction in the English orthography. For half the students the code-emphasis component focused exclusively on the phoneme-grapheme correspondences, the other half were also given explicit instruction to syllable types and morphological structure. The results are encouraging in finding that both groups made discernible gains in word recognition and reading comprehension over the four-month period; as did virtually every child in the study (individual data are provided). There was no evidence that instruction in syllables and morphemes had an obvious advantage. Readers will find this paper useful on a number of ways: for the explicit details in lesson plans which are tied to readily available commercial programs and for the result that the only limiting factor was RSN—and that limited not mastery of the code, but speed of word recognition. As the title suggests, the study indicates that 7th graders are not too old to benefit from instruction.

In chapter 10, Marshall Raskind and Eleanor Higgins provide some surprising and encouraging evidence that speech recognition technology designed to help persons compensate for reading limitations may in fact enhance reading and spelling as well—gains in word recognition, spelling, and reading comprehension were small but reliable after only one semester using this technology an hour a week. This carefully conducted study will be read with keen interest by all who struggle with how to support students who must continue in grade-level curriculum and yet also continue to learn to read. Combined with prior evidence that text readers help the poor reader, school systems, families and clinicians will be expanding their repertoire on aids to older students.

If you talk to any group of experienced reading instructors, you will find that their number one concern is how to enhance reading fluency. For even very effective code-emphasis interventions have not yielded sizable gains in reading fluency. In Chapter 11, Marianne Meyer and Rebecca Felton bring us up to date on what research finds regarding the efficacy of means to improve reading fluency, with particular emphasis on the "repeated readings" approach. This paper will be especially useful to reading instructors, as it is structured in a question answer format.

The final paper, chapter 12 by Joanne Martila Pierson offers an unusual—and very readable—combination of explicit code instruction and concern for the child's continued interest. What I like about this paper is the explicit documentation of what the child does and does not learn over the period covered and the honest reflections on what motivational efforts can and cannot do in promoting reading success. My suspicion will be that many clinicians will find their own attempts to "capture" a student's interest mirrored in this paper and will be encouraged to be creative in their efforts to spur interest, while at the same time keeping their eye on the mastery of the system.

It's Never Too Late to Remediate: Teaching Word Recognition to Students with Reading Disabilities in Grades 4–7[1]

Sylvia P. Abbott and Virginia W. Berninger

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Twenty children in fourth through seventh grade participated in 16 one-hour individual tutorials over a four-month period. Half of the children received structural analysis and alphabet principle training; half received only alphabetic principle training; all received training in orthographic and phonological skills, practice in oral reading of connected text, and monitoring strategies for comprehension. Results showed that the children improved reliably in reading and related measures. Treatment condition did not predict rate of growth. Only rapid automatic naming of letters predicted response to intervention and only on rate of real word reading. Results of this study indicate that upper elementary and middle school students who have not yet mastered accuracy and automaticity of word recognition should be given explicit instruction in word recognition, especially in the alphabetic principle. The benefits of structural analysis training were evident only in trends for individual students on hierarchical linear modeling (HLM) growth analyses.

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INTRODUCTION

In her 1983 study, Chall made an important distinction between learning to read and reading to learn. The learning-to-read stage of instruction typically occurs during the primary grades, whereas the reading-to-learn stage typically begins during the intermediate grades. The timing of this developmental shift in focus of instruction may work well for many children who master basic word skills such as accurate and fluent word recognition in the primary grades. However, this developmental timing does not effectively accommodate those children who are still learning to read when the instructional shift occurs. For those children who continue to need explicit instruction in word recognition skills, the curriculum shifts its focus (from learning to read to reading to learn) too early. Such children are still in the learning-to-read stage, but can continue to make progress only if given explicit instruction at their level of development. A common scenario for these delayed readers is that not only is word recognition not explicitly taught in the intermediate grades but also the readability of the materials used is well beyond their instructional level. Little research has addressed this developmental mismatch between children's reading levels and the focus of curriculum. This developmental mismatch is especially problematic for students with dyslexia.

A growing body of research shows that early intervention (i.e., intervention before third grade) enhances the probability that students with reading disabilities will develop adequate reading skills (Lyon 1995). It does not follow, however, that early intervention alone is sufficient to meet the needs of all students with reading problems. Although many students benefit from the boost of early intervention (Abbott, Reed, Abbott, and Berninger 1997; Torgesen, Wagner, and Rashotte 1997; Vellutino, Scanlon, Sipay, Small, Pratt, Chen, and Denckla 1996), others will continue to need instructional support, sometimes for the remainder of their school years.

The research on early intervention has shed light on the beginning skills necessary for learning-to-read. Four skills need to be taught and learned at the beginning of the learning-to-read stage (Berninger 1998b). Children must acquire:

1. Orthographic knowledge in the form of naming letters, recognizing letters in words, and writing letters.
2. Phonological awareness in terms of segmenting spoken words into phonemes.

3. A knowledge of the alphabetic principle so that they can integrate letter and phoneme knowledge.
4. The ability to apply the alphabetic principle in decoding unfamiliar words and in recognizing familiar words.

However, additional skills must be acquired in order for children to deal with longer words and progress from the beginning to the advanced phase of learning to read. Adams and Henry (1997) discussed two skills needed to move beginning readers along the developmental continuum of word recognition: the six syllable patterns in written English; and morpheme patterns from the Anglo-Saxon, Romance (Latin and French), and Greek layers of the English language.

The working hypothesis of the research described in this article is that some students in the intermediate grades will need explicit instruction in beginning and/or advanced word recognition skills to become proficient readers. The research was designed to answer three questions:

1. Is instructional intervention effective in raising reading achievement in older, underachieving readers?
2. Is an instructional protocol that incorporates a beginning and an advanced skills component for word recognition more effective in raising reading achievement than one that incorporates only a beginning skills component?
3. Do individual differences in older, underachieving learners affect their response to instruction for word recognition?

EFFICACY OF REMEDIATION IN THE OLDER, UNDERACHIEVING READER

Prior research studies provided evidence for the hypothesis that instructional intervention directed toward learning to read may be effective for children with reading disabilities, even at a grade level when curriculum normally focuses on reading to learn.

In one study, Lovett and Steinbach (1997) tested the hypothesis that phonological deficits in reading can be remediated across the elementary grades. Their sample, which was significantly impaired in single-word reading (third to fourth percentile on average), spanned three grade groups: second/third, fourth, and fifth/sixth. They compared a treatment aimed at phonological decoding and a treatment aimed at word identification strategies; both treatments were significantly more effective than a control treatment aimed at classroom survival skills. Consistent with their hypothesis, the 35-hour treatment program, delivered to groups of two or three children, worked equally well at all grade levels. The older students were just as responsive as the younger students. Following treatment, the participants had made statistically significant improvements but still scored well below age-level norms on the Word Identification or Word Attack subtests of the Woodcock Reading Mastery Test-Revised (Woodcock 1987).

In a second study, Alexander, Anderson, Heilman, Voeller, and Torgesen (1991) evaluated the effectiveness of the *Auditory Discrimination in Depth Program* (ADD) in remediating the phonological decoding of ten students with severe dyslexia whose average age was 10.8 years. All but one had a discrepancy of at least 1.5 *SD* between their full scale IQ and a standardized measure of single-word reading. Children received, on average, 64 hours of individual training that used sensory feedback from the eye, ear, and mouth in identifying, classifying, and labeling consonant and vowel sounds. After children developed metalinguistic awareness of the motor characteristics of speech sounds, they learned to associate the sounds with corresponding alphabet letters. Following training, their average standard scores increased from 75.1 to 87.6 on the Word Identification subtest and from 77.2 to 98.4 on the Word Attack subtest of the 1973 version of Woodcock Reading Mastery Test.

Our study differed in four ways from these two studies:

1. Our inclusion criteria were less stringent. We hope that our sample may be more representative of the range of severity typically served in resource rooms. All participants had unexpectedly low achievement for their intelligence levels but were not necessarily at the very bottom of the reading distribution.
2. Our intervention was of shorter duration—about half that of Lovett and Steinbach (1997) and about a quarter that of Alexander et al (1991).
3. The instructional protocol was designed to aim the teaching in each session to all levels of language—subword, word, and text—to create a functional reading system (Berninger et al. 1997; Berninger 1998a; Berninger 1998b).

4. HLM analysis of growth curves (Bryk, Raudenbush, and Congdon 1996) was used to evaluate response to intervention for each individual and each treatment group.

RELATIVE EFFECTIVENESS OF BEGINNING SKILLS ONLY VERSUS COMBINED BEGINNING AND ADVANCED SKILLS

Considerable research evidence exists that training in orthographic knowledge, phonological awareness, alphabetic principle, phonological decoding, and word-specific reading is effective when a curriculum focuses on learning to read (e.g., Adams 1990; Ehri 1992; Gough, Juel, and Griffith 1992). The same kind of training may be effective in later years if these skills have not already been mastered. However when taught later, these skills may be learned more effectively if coupled with training in the advanced skills of syllable types and morpheme patterns. A word longer than one syllable is difficult to decode without analyzing the internal structure of the word. This skill of analyzing internal word structure—referred to as structural analysis—draws on syllable and morpheme knowledge in decomposing a word into its parts to derive its pronunciation and meaning.

In structural analysis approaches, students are taught not only to count the number of syllables in a word but also that each syllable contains a vowel sound. They also are taught that in polysyllabic words, one syllable is given primary stress, and that in English, the stressed syllable is often the first one in the word. Additionally, students are taught to distinguish among the six vowel-based syllable types in English: closed, open, silent *e*, vowel team, *r*-controlled, and *-le* (Moats 1995). Students also learn that words of Anglo-Saxon origin have characteristic vowel (V) and consonant (C) patterns—for example, VCCV, VCV, VCCCV, and CVVC—that can be used to segment long, unfamiliar words into syllables and then be decoded using spelling-phoneme knowledge. Balmuth (1982) showed that students have more difficulty recognizing written syllables than hearing syllables in spoken words. Segmentation of the written word does not always correspond in a one-to-one fashion with segmentation of the spoken word. For example, the written word *bunny* would be divided between the repeating *n*'s, but phonologically there is only one /n/ phoneme in the spoken word. Students also learn that accent patterns influence syllable patterns. Although the letter-sound correspondences in words derived from Romance languages are usually simple, the stress patterns are not. The schwa, or unstressed vowel sound, is common (e.g. excellent). Letter-sound correspondence alone cannot be used to determine the appropriate spelling of the schwa which is a reduced vowel; its spelling must be learned for specific word contexts.

Structural analysis approaches also introduce morphemic analysis; that is, analyzing words into their morphemes or meaning units. These units are either free or bound morphemes. Free morphemes can stand as whole words and cannot be divided without losing their meaning. Bound morphemes (for example, *-s*, *-es*, *-ed*, *-er*, *-est*) cannot stand alone but can be combined with a free morpheme such as clean, to modify its meaning. Most English words are of Anglo-Saxon, Romance, or Greek origin, each with distinct morpheme patterns. Anglo-Saxon morphemes consist of compound words, prefixes, and suffixes. Romance morphemes consist of roots (*vis*, *tract*, *ped*), prefixes, and suffixes. Greek morphemes consist of two equally important parts (*tele* + *scope*, *auto* + *graph*).

Unfortunately, this structural analysis approach is not taught in many classrooms in either the upper primary grades or intermediate grades. Henry (1988) assessed third through fifth grade students' ability to identify patterns within written words and found that they had limited knowledge of word structure. They had difficulty dividing words into syllables, and few used syllable division as a strategy for analyzing long, unfamiliar words. Henry also found that neither normally developing nor reading disabled students were able to identify or understand common morpheme patterns in words. One reason that many children are not taught morpheme patterns is that educators think students should master all letter-sound correspondences before learning to analyze the structure of polysyllabic words. Likewise, Just and Carpenter (1987) and O'Rourke (1974) reported that many grade school and high school students never master common prefixes and suffixes (bound morphemes), probably because they are not taught their meanings explicitly and do not infer the meanings on their own.

Research evidence supports the value of teaching structural analysis of words. Henry (1988) compared typical third, fourth, and fifth graders who received basal reader and spelling instruction to those who received decoding and word structure training based on word origin. Those who received both decoding and structural analysis improved more in reading and spelling performance than those who received only a basal approach. Henry, Calfee, and Avelar-LaSalle (1989) taught five specially designed units combining decoding and structural analysis. As a group, students improved from 15 percent to 50 percent correct on prefixes and from 18 percent to 55 percent correct on syllables. Based on her research, Henry (1990) published *Words*, a curriculum designed to make students aware of how different word patterns (letter-sound correspondence, syllable, and morpheme) are related to word origin. Readers are taught to look first for familiar morphemes in unfamiliar words, then for syllable divisions, and finally for letter-sound correspondences.

Based on the research of Henry and her colleagues, we tested the hypothesis that children would improve at word recognition more rapidly if given training in both the *beginning phase* (orthographic knowledge, phonological awareness, alphabet principle, decoding, and word specific practice) and the *advanced phase* (syllable types and morpheme patterns based on word origins) of word recognition, rather than training in the beginning phase only. We used portions of Henry's (1990) curriculum for the advanced phase and tested the hypothesis not only for treatment groups but also for individuals in treatment groups.

INDIVIDUAL DIFFERENCES IN UPPER ELEMENTARY LEARNERS

Rate of growth in response to instruction may be related to individual differences in students and not just to curriculum or instruction. Prior research has identified individual difference variables that predict slopes of growth curves in early intervention for reading problems. Such predictions include orthographic coding, phonological awareness, rapid automatized naming skills, and verbal IQ (Berninger, Abbott, Zook, Ogier, Lemos, and Brooksher 1999). We wondered whether these same individual difference variables would predict response to intervention in the upper elementary grades.

METHOD

PARTICIPANTS

Twenty students (13 males and 7 females) enrolled in fourth (n = 4), fifth (n = 4), sixth (n = 10), or seventh grade (n = 2) were identified as low achieving in reading as a result of testing at the University of Washington Learning Disabilities

Center in Winter 1997. These children's families were participating in a family genetics study; therefore, results may generalize to students whose families have multigenerational histories of learning disabilities. All students were underachieving in reading (more than a standard deviation between their score on WRMT-R Word Identification or Word Attack subtests and their prorated WISC-III Verbal IQ) and most were more than a standard deviation below the mean on those reading measures. Their average prorated Verbal IQ on the WISC-III (Wechsler 1991), which has a mean of 100 and a standard deviation of 15, was 102.55 (SD = 12.82). Their average Word Attack subtest score on the WRMT-R, which has a mean of 100 and a standard deviation of 15, was 83.90 (SD = 13.12) and their mean Word Identification subtest score on the WRMT-R, which also has a mean of 100 and a standard deviation of 15, was 81.25 (SD = 14.24) at the beginning of the study. The mean chronological age was 11.54 years (SD = 0.98 years) and ranged from 9.58 years to 13.16 years.

Background information was obtained for each participant from a questionnaire completed by the parents of all 20 participants. Parents answered questions about their educational level, ethnicity, family history of reading problems, child's educational history including current and past special services, and the amount of time the child reads outside of school. Ethnic background of the students was 90 percent European-American (7 girls and 11 boys) and 10 percent Asian-American (2 boys). Mothers' level of education, which is one index of socioeconomic status, included 25 percent high school, 50 percent community college or vocational technical, 15 percent college, and 10 percent some graduate study. Three children (15 percent) were left handed. Of the 20 children, 90 percent received resource room services prior to this study (35 percent had received services from first grade) and 70 percent continued to receive special services (from 20 to 60 minutes a day) during the study. None of the remaining 10 percent received special services for the first time during the study. Despite these special services, all students had struggled throughout their schooling with reading. Prior to the study, only one child reported no reading outside of school hours. The remaining 19 children reported reading outside of school from as little as 20 minutes a day (n = 1) to as much as two hours per day (n = 4); those that read for a longer time did not necessarily read more, as they may have read more slowly.

OVERVIEW OF INSTRUCTIONAL INTERVENTIONS

The students were assigned, on the basis of a random numbers table, to one of two treatment conditions. Table I summarizes both the variable and constant components of the two conditions. The two conditions differed in whether the students were given structural analysis training. The structural analysis group received 15 minutes of Henry's (1990) *Words* program that included explicit instruction in syllable types and morpheme patterns according to word origin. The study skills (control) group received 15 minutes of study skills training. The conditions also differed in how words were practiced during the phonological decoding and oral reading components of each lesson. In the phonological decoding component, children in the structural analysis group were encouraged to apply their knowledge of syllable structure and morpheme patterns. Similarly, when students made errors during text-level oral reading, tutors pointed out how syllable and morpheme information could be used to figure out correct pronunciations. In contrast, no mention of syllable structure or morpheme patterns was made to children in the study skills group during the phonological decoding or oral reading components. Children in both conditions received training in the components for beginning word recognition: phonological and orthographic awareness, alphabetic principle, phonological decoding, and oral reading of specific words. Children in these treatment conditions did not differ in mean age, grade, or mother's level of education.

Each student participated in one-hour individual tutorial sessions weekly for 16 weeks. These sessions began in March 1997, and were completed by the end of June 1997. Standard scripted lessons were designed based on the previously established, necessary components for developing a functional reading system (Berninger et al. 1997; Berninger 1998b). Lessons were designed for fast-paced tutor-student interaction and a high rate of student response. Elements of direct instruction (tutor modeling and student repeating response) were included, along with prescribed procedures for correcting children's errors. Each of the components is discussed in greater detail below.

Phonological and Orthographic Skills. Words taken from the vocabulary list at the beginning of each story in the *Decoding Strategies Student Book* (Engelmann, Meyer, Johnson, and Carmine 1988) were used for the phonological and orthographic activities at the beginning of each session. That is, phonological

Table I. Constant and varying[a] components in two instructional groups.

Language Level	Time (mins)	Structural Analysis Group (SA)	Study Skills Group (SS)
Subword	6	Phonological/ Orthographic Skills	Phonological/ Orthographic Skills
Subword	5	Alphabet Principle Training	Alphabet Principle Training
Word	10	***Phonological Decoding***[b]	***Phonological Decoding***[c]
Word(SA)/ Text (SS)	15	***Structural Analysis***	***Study Skills***
Text	24	Oral reading with ***error correction,*** comprehension monitoring, rereading for fluency	Oral reading with ***error correction,*** comprehension monitoring, rereading for fluency

[a]Varying components are bolded and italicized.

[b]Highlighting syllable/morpheme structure as well as alphabet principle

[c]Highlighting only alphabet principle

and orthographic skills were yoked to the vocabulary that children would read later in the session. For the *phonological training* component, the goal was to develop awareness of phonemes in the vocabulary words when spoken aloud. Tutors told the student to say a word (e.g., *turn*), then to say the target word without a designated phoneme (e.g., /t/). If the student responded correctly, the next word was presented. If the student answered incorrectly, the tutor demonstrated how to segment the sounds using colored disks to represent each sound segment. If the student could segment the word using the disks to represent the sounds, the next word was presented. If not, one more teaching and testing trial was presented, followed by the next word. For the *orthographic training* component, the goal was to develop awareness of each letter in the written version of the vocabulary word. Words from the story were printed on the board. The tutor swept her finger from left to right under the word and directed the student to look at the word. The tutor then covered the word and asked the student to spell the word. If the student did not spell the word correctly, the tutor pointed out the missed letters, then repeated the procedure before presenting the next word.

Alphabetic Principle Training. The goal of this component was to use skills acquired from orthographic and phonological training when learning specific spelling-sound correspondences. During this component, 109 of the most frequent spelling-sound correspondences of written English were explicitly taught using *Talking Letters* (Berninger 1998b) and a connectionist, nonrule-based approach. The spelling-sound correspondences were organized into "orders" based on the degree of predictability (see Appendix). These orders, derived from Venezky's (1995) theory, have been used in four of our prior studies. Orders 0-a and 0-b cluster as easy predictability, orders 1–4 cluster as moderate predictability, and orders 5, 6, and 7 cluster as low predictability (Berninger et al. in press). For each correspondence, the tutor would point to and name a letter or group of letters, then name a picture that contained the target phoneme associated with that 1- or 2-letter spelling unit, and finally produce the sound that went with the spelling unit. Next, as in direct instruction, the student repeated pointing to and naming the letter(s), naming the pictured word, and producing the phoneme (for example, *a*, *apple*, /a/).

Phonological Decoding. The goal of this component was to apply the alphabet principle to real words that would appear later in the reading selection. The Structural Analysis Group spent 10 minutes applying phonics and structural analysis to decoding vocabulary words. For each word, the student was asked to divide the word into syllables, sound out the spelling-sound correspondences within syllables, then blend the syllables to make a whole word (*boat/ing*, then *b-oa-t-i-ng*, then *boating*). If a student needed help, the tutor was to model use of the structural analysis strategies being taught.

In contrast, the Study Skills Group used synthetic phonics strategies to sound out the same words. They were asked to sound out each grapheme (/b/ /ō/ /t/ /ĭ/ /ng/) and blend the resulting phonemes to synthesize a whole word. If the student was unable to segment and blend a word, the tutor modeled the phoneme synthesis procedure but did not model analyzing the word into its syllables or morphemes.

Structural Analysis. Using *Words* (Henry 1990) tutors instructed students in layers of language based on word origin (Anglo-Saxon, Romance, and Greek). Syllable patterns, morpheme patterns, and strategies for decoding, reading, and spelling long words were covered. Students were taught to check for affixes and roots, then divide the word into syllables, and finally, if needed, to use letter-sound correspondence. When the *Words* lesson introduced spelling activities, children first repeated the word, then listened for syllables, and then identified common affixes and roots. They were encouraged to use letter-sound correspondences only after attempting the morpheme and syllable strategies.

Study Skills. The students in this condition used a commercially available study skills workbook (Drumm 1996). Lessons spanning grade levels 2 through 8 were used. The tutor worked with the students on such skills as outlining, writing paragraphs, note-taking, and using an index. Tutors invited students to relate their current classroom assignments to the lessons taught in the tutorial.

Oral Reading of Connected Text for Meaning. The final 24 minutes of the tutorial were spent orally reading and rereading stories taken from *Corrective Reading Skill Applications* (Englemann et al. 1988). Stories from student books B1, B2, and C were chosen, progressing from texts with tightly controlled syntax and vocabulary to less controlled texts that were more representative of texts typically encountered in classrooms. Procedures in the teacher's manual for this program were not followed. Our procedures for this research included comprehension monitoring but not explicit instruction in comprehension. As children read, corrections were made as needed, according to treatment condition. That is, those students in the Structural Analysis Group were told to divide the word into syllables, sound out the syllables, and then pronounce the word using the strategies taught. Students in the Study Skills Group were taught to use the letter-sound correspondences from Talking Letters to sound out difficult words. If a student in either group was still unable to read the word, the tutor spelled the word and then supplied the name of the word to form a connection at the whole word level.

TUTORS AND FIDELITY OF TREATMENT IMPLEMENTATION

Tutors included school psychologists and graduate students in school psychology or teacher education, and were trained by the first author prior to beginning tutoring. Once tutoring began, tutors audiotaped each tutoring session. Audiotapes were reviewed by the first author who discussed with tutors any deviations in standard implementation of procedures. Deviations were rare after the first two sessions. Tutors also met regularly to solve potential problems related to motivation or behavior.

LESSON PLANS

Part I of the Appendix contains the spelling-sound correspondences taught in the alphabet principle component, organized by order of difficulty (see Abbott et al. 1997 for a discussion of the theoretical rationale for orders and difficulty). Part II of the Appendix refers the reader to the actual page numbers from

Henry's *Words Program*, Drumm's *Social Skills Program*, and Englemann et al.'s *SRA Decoding Program* for each lesson.

OVERVIEW OF ASSESSMENT MEASURES

A time schedule for the administration of tests is presented in table II. The pretest battery included the following:

1. A prorated verbal IQ test based on the WISC-III (Wechsler, 1991) Information, Similarities, Vocabulary and Comprehension subtests.
2. Measures of orthographic knowledge including the University of Washington Letter Cluster Orthographic Coding Test (Berninger, Yates, and Lester 1991); the Colorado Perceptual Speed Test (DeFries 1985); and the Orthographic Choice Task (adapted from a computer-based test developed by Olson, Kliegl, Davidson, and Foltz 1985).
3. Measures of phonological processing include syllable deletion and phoneme deletion on the Modified Rosner Test of Auditory Analysis Skills (Berninger, Thalberg, DeBruyn, and Smith 1987). We also presented prepublication versions of phonological segmentation and nonword memory measures from Wagner and Torgesen's (1999) Comprehensive Assessment of Phonological Skills.
4. A reading comprehension measure (Woodcock 1987).
5. Qualitative Reading Inventory (QRI), an informal reading inventory for connected text that yields instructional level in grades (Leslie and Caldwell 1990) and of taught words.
6. A measure of rapid automatized naming (RAN) for letters (Wolf, Bally, and Morris 1986).
7. Measures of accuracy including the Word Identification and Word Attack subtests of the Woodcock Reading Mastery Test-Revised (1987) and prepublication speed of reading single real words or pseudowords (Wagner and Torgesen 1999).
8. Measures of spelling from the Wechsler Individual Achievement Test (WIAT, Psychological Corporation 1992) and Wide Range Achievement Test-Third Edition (WRAT-3, Wilkinson 1993).

At midtest, after 8 lessons, the single-word reading and spelling measures were repeated because they were thought to

Table II. Time schedule for administration of tests.

	Pretest	Midtest	Posttest
WISC III:	X		
Information, Similarities, Vocabulary, and Comprehension subtests			
Letter Cluster Coding	X		X
Colorado Perceptual Speed Test	X		X
Orthographic Choice Task	X		X
Syllable and Phoneme Deletion	X		X
Phonological Segmentation	X		X
Nonword Memory Test	X		X
Qualitative Reading Inventory	X		X
Rapid Automatized Naming (RAN) of Letters	X		
Woodcock Johnson-Revised:			
Word Identification	X	X	X
Word Attack	X	X	X
Passage Comprehension	X		X
Real Word and Non-word Reading Efficiency Subtests	X	X	X
Wechsler Individual Achievement Test Spelling Subtest	X	X	X
Wide Range Achievement Test-3rd Edition Spelling	X	X	X
Taught Words	X		X

be the most sensitive to the effects of structural analysis training. The Woodcock, WIAT, and WRAT-3 measures were age-corrected standard scores. The RAN measure was a time score in seconds. The QRI was a criterion-referenced grade level. All the other measures were accuracy scores.

At posttest, after 16 lessons, a battery was administered that included measures of phonological and orthographic skills, accuracy and speed of single-word reading, spelling, text reading, and comprehension. Table III reports the means and standard deviations for each measure administered at two time points, and for the one measure (RAN) other than verbal IQ that was

Table III. Means and standard deviations (*SD*) for each treatment group on outcomes measured only once or twice.

	Structural Analysis		Study Skills	
	Pretest Mean (*SD*)	Posttest Mean (*SD*)	Pretest Mean (*SD*)	Posttest Mean (*SD*)
Orthographic Letter Cluster	85.90 (8.41)	89.40 (7.89)	84.70 (5.68)	91.20 (3.16)
Colorado Perceptual Test	37.64 (9.98)	40.22 (12.04)	28.76 (9.32)	33.03 (12.21)
Orthographic Choice	79.23 (16.10)	81.54 (11.85)	76.92 (4.56)	75.16 (9.33)
Phoneme Segmentation	21.50 (4.97)	25.10 (5.71)	20.60 (3.10)	25.50 (2.46)
Syllable Segmentation	6.20 (2.20)	7.40 (2.01)	5.60 (2.37)	6.80 (1.40)
Wagner-Torgesen Segmentation	12.30 (4.06)	18.40 (4.77)	8.80 (2.62)	17.80 (4.24)
Wagner-Torgesen Memory	16.60 (3.66)	18.20 (3.85)	17.10 (3.35)	20.00 (0.39)
WRMT-R Passage Comprehension	87.40 (24.16)	95.90 (20.64)	80.60 (17.32)	88.70 (15.76)
QRI (instructional level for text reading)	3.80 (1.98)	4.80 (2.04)	2.78 (1.77)	3.33 (1.82)
RAN Letters	25.8 (5.1)		32.4 (7.8)	

given only once. Table IV reports the means and standard deviations for each measure administered at three time points.

RESULTS

ANALYSES

To answer the three research questions, a repeated measures ANOVA was used to examine effects over time for measures obtained at pretest and posttest (see table III), and HLM (Bryk et al. 1996) growth curve modeling (Bryk and Raudenbush 1987) was used to examine effects over time for measures that were obtained at pretest, midtest, and posttest (see table IV). (Three time points are needed for growth curve analysis.) There were no statistically significant differences between groups at pretest on any measure in Tables III or IV or in the amount of reading students did outside of school. We use Bryk and Raudenbush's HLM growth curve modeling rather than growth curves based on ordinary least squares regression for several reasons. First, HLM growth curve modeling handles missing data well. Second, HLM growth curve modeling has been shown to have smaller standard errors in cross-validation and, therefore, better reliability in estimating slopes of individual growth curves. Third, the regression is fitted with information from the individual's score and from all the members in the group. Finally, the multilevel feature allows us to compare treatments at the group level and to assess each student's growth in response to intervention at the individual level. Therefore, in this study, we analyzed response to treatment for both groups and individuals (see Abbott and Berninger 1995; Berninger and Abbott 1994).

Table IV. Means and standard deviations (*SD*) for each treatment group on outcomes measured at three timepoints.

	Structural Analysis			Study Skills		
	Pretest Mean (*SD*)	Midtest Mean (*SD*)	Posttest Mean (*SD*)	Pretest Mean (*SD*)	Midtest Mean (*SD*)	Posttest Mean (*SD*)
Word Identification	85.40 (16.29)	86.10 (20.11)	90.30 (15.85)	77.10 (11.15)	78.80 (7.82)	82.30 (9.50)
Word Attack	84.10 (16.80)	83.30 (14.68)	89.40 (12.18)	83.70 (9.02)	84.50 (11.68)	87.30 (9.46)
Taught Words	25.60 (10.72)	28.10 (9.89)	31.00 (8.59)	19.22 (8.50)	23.89 (8.33)	25.00 (8.94)
WIAT Spelling	82.40 (12.17)	87.20 (11.44)	86.80 (11.44)	80.00 (9.21)	82.44 (11.16)	83.78 (13.90)
WRAT-3 Spelling	86.40 (13.73)	87.70 (11.20)	89.60 (12.22)	81.22 (10.10)	80.89 (8.98)	81.33 (8.80)
Real Word Reading Efficiency	50.40 (14.27)	52.70 (13.93)	53.30 (13.90)	42.89 (5.90)	45.11 (7.20)	45.89 (8.22)
Nonword Reading Efficiency	22.89 (8.61)	23.44 (10.81)	24.56 (9.57)	16.57 (7.21)	18.72 (7.57)	17.71 (8.10)

EFFICACY OF REMEDIATION IN THE OLDER, UNDERACHIEVING READER

As shown in table V, there was a significant trials effect (improvement over 16 lessons) for each measure except orthographic choice that was measured at two time points. As shown in table VI, slopes were significant, indicating reliable improvement, on all measures at three time points, except nonword reading efficiency. Thus, with the exception of orthographic choice and nonword reading efficiency, children improved reliably on all reading, spelling, and related skills the intervention was designed to improve. For the standardized measures, these gains were in age-corrected standard scores which represent relative gains compared to age-peers.

Table V. Analysis-of-Variance results for outcomes measured at pretest and posttest.

	Treatment			Trials		Treatment x Trials		
	MS	*F*	MSE_a	*MS*	*F*	*MS*	*F*	MSE_b
Orthographic Letter Cluster	0.90	0.01	74.25	250.00	18.71***	22.50	1.68	13.36
Colorado Perceptual Test	644.97	2.81	229.78	117.01	11.08**	7.17	0.68	10.57
Orthographic Choice	188.57	0.81	232.18	0.75	0.03	41.39	1.92	21.58
Phoneme Segmentation	0.63	0.02	32.76	180.63	48.78***	4.23	1.14	3.70
Syllable Segmentation	3.60	0.67	5.36	14.40	5.02*	.00	.00	2.87
Wagner Segmentation	42.03	2.11	19.90	570.03	47.19***	21.03	1.74	12.08
Wagner Memory	13.23	0.77	17.18	50.63	15.28***	4.23	1.28	3.31
Passage Comprehension	490.00	0.67	733.67	688.90	15.24***	0.40	0.01	45.21
QRI (instructional level for text)	14.67	2.10	6.98	5.73	17.36***	0.47	1.42	0.33

* $p < .05$** $p < .01$ *** $p < .001$

MSE_a is used to test the treatment effect for significance.

MSE_b is used to test the trials and treatment x trials interaction for significance.

Table VI. Intercepts and slopes of overall growth curves in total sample.

	Intercept	*t*	Slope	*t*
Word Identification	59.77	23.59**	2.75	5.15***
Word Attack	21.68	12.10***	1.62	2.96**
Taught Words	23.35	10.60***	2.66	6.15***
WIAT Spelling	24.68	23.95***	1.48	4.05***
WRAT-3 Spelling	26.45	33.94***	0.61	3.68**
Real Word Reading Efficiency	47.29	18.88***	1.54	3.23**
Nonword Reading Efficiency	18.94	8.72***	0.92	1.93

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

TREATMENT EFFECTS

Group Analyses. As shown in table V, neither the treatment effect nor treatment x trials effect was ever significant for measures obtained at two time points. As shown in table VII, treatment never reliably predicted the slope for measures obtained at three time points. The lack of a treatment effect is not due to preexisting differences between treatment groups as the intercepts in table VIII were not significantly different.

Individual Analyses. For measures with three data points, we were able to examine individual growth curves within each treatment. For measures with two data points, we examined change from pretest to posttest for individual subjects. In table IX, a check indicates that an individual child was a treatment responder (growth curve significantly different from chance or posttest higher than pretest) on a learning outcome measure. As evident on that table, there was a trend toward greater individual treatment response within the

Table VII. Is treatment predictive of intercept and slope?

	Intercept	*t*	Slope	*t*
Word Identification	–5.83	–1.16	0.20	0.19
Word Attack	–0.38	–0.10	–0.35	–0.32
Taught Words	–4.38	–0.99	–0.08	–0.08
WIAT Spelling	–0.45	–0.21	–0.45	–0.61
WRAT-3 Spelling	–1.28	–0.81	–0.48	–1.44
Real Word Reading Efficiency	–6.79	–1.39	0.18	0.18
Nonword Reading Efficiency	–3.40	–0.78	0.20	0.21

Table VIII. Intercepts and slopes of growth curves in structural analysis and study skills treatments.

	Structural Analysis		Study Skills	
	Intercept	Slope	Intercept	Slope
Word Identification	62.68	2.65	56.85	2.85
Word Attack	21.87	1.80	21.48	1.45
Taught Words	25.53	2.70	21.16	2.63
WIAT Spelling	24.90	1.70	24.45	1.25
WRAT-3 Spelling	27.08	0.85	25.81	0.38
Real Word Reading Efficiency	50.68	1.45	43.89	1.63
Nonword Reading Efficiency	20.64	0.82	17.24	1.02

structural analysis group than within the study skills group on five of the seven measures for which three data points were available. This trend could be seen on all measures except WIAT (on which equal individual improvement was seen in the two groups) and nonword efficiency (on which the study skills group showed more improvement). For the two measures with only two data points, the structural analysis group included more treatment responders. When only the word-level measures—which were hypothesized to be more sensitive to structural analysis training—were considered (all but QRI which assesses text reading), a sign test showed significantly more positive outcomes at the individual level for the structural analysis group than for the study skills group ($p <$ .035, one tailed).

To compare the amount of growth across treatment groups, we transformed the change in mean slope for the treatment responders in each group to grade equivalents based on published norms for the two reading measures. On average, the treatment responders in the structural analysis group advanced 8 months in word identification skill levels and the treatment responders in the study skills group advanced 7 months. On Word Attack, the treatment responders in the structural analysis group advanced an average of 11 months and the treatment responders in the study skills group advanced 5 months. Although the groups were nearly equivalent in the amount of gain in real word reading, the treatment responders in the structural analysis group gained more than those in the study skills group in pseudoword reading.

Table IX. Improvement on measures for individual participants.

	Word ID	Word Attack	Taught Words	WIAT	WRAT	Word Effic.	Nonword Effic.	QRI level	Ortho choice
Structural Analysis Group									
1	√	√			√	√	√		√
2	√	√	√	√			√	√	√
3	√	√		√	√	√		√	
4	√	√	√		√				
6		√	√		√	√		√	
7	√	√		√	√	√		√	
12	√		√	√	√	√	√	√	√
15	√	√	√	√	√	√	√	√	√
17				√	√	√	√	√	
20	√			√	√	√			
Total Improved	**8**	**7**	**5**	**7**	**9**	**8**	**5**	**7**	**4**
Study Skills Group									
5				√	√	√	√	√	√
8		√		√		√	√		√
9	√				√	√	√		
10	√	√		√	√		√		
11	√	√	√	√	√			√	√
13	√	√				√	√		
14	√	√		√				√	
16	√		√				√	√	
18	√	√	√	√	√	√	√		
19				√		√		√	
Total Improved	**7**	**6**	**3**	**7**	**5**	**6**	**7**	**5**	**3**

[a]For the first seven measures, a check (√) means the growth curve was significantly different from chance. For the last two measures, it means that the posttest score was higher than the pretest score.

That treatment is received at all may be more important than which specific kind of treatment is received. As we have reported before in treatment studies based on a systems approach aimed at multiple components of a functional system (Abbott et al. 1997; Hart, Berninger, and Abbott 1997), all children participating responded to treatment on some learning outcome measures, regardless of which treatment group they were in.

INDIVIDUAL DIFFERENCES IN UPPER ELEMENTARY LEARNERS

The multilevel features of HLM were used to examine whether the pre-intervention levels of individual difference measures were related to the intercept and slope of individual growth curves. Of the preintervention measures considered (phonological coding, orthographic coding, phonological nonword memory, instructional level on the QRI, prorated WISC-III VIQ, and RAN letters), only two predicted parameters of the growth curves. As shown in table X, prorated Verbal IQ predicted the intercept, or level of skill development prior to intervention, but not slope, or response to intervention. As shown in table XI, RAN letters predicted the intercept for taught words and nonword reading efficiency and the slope for real word efficiency.

DISCUSSION

Older, underachieving readers in the upper elementary and middle school grades benefit from instructional intervention in reading. Children improved about 5 standard score points (1/3 standard deviation) on standardized measures of single word reading after just sixteen 1-hour individual tutorials. These children started out at a low reading level, but not as low as that of the children in Lovett and Steinbach's (1997) study. They ended up at a higher level than the participants in that study but failed to reach the performance level achieved by participants in the Alexander et al. (1991) study, which provided about four times

Table X. Does Verbal IQ predict growth curve intercept and slope?

	Intercept	*t*	Slope	*t*
Word Identification	0.70	5.43***	–0.08	–1.90
Word Attack	0.40	3.57**	–0.05	–1.15
Taught Words	0.51	3.83***	–0.04	–1.26
WIAT Spelling	0.19	2.74*	0.02	0.84
WRAT-3 Spelling	0.17	3.35**	–0.00	–0.18
Real Word Reading Efficiency	0.62	4.34***	0.02	0.50
Nonword Reading Efficiency	0.43	2.90**	0.03	0.73

*$p < .05$ **$p < .01$ ***$p < .001$

Table XI. Does rapid automatized naming for letters predict growth curve intercept and slope?

	Intercept	*t*	Slope	*t*
Word Identification	−0.85	−2.77	0.08	1.04
Word Attack	−0.45	−1.88	0.03	0.34
Taught Words	−0.74	−2.76*	0.03	0.46
WIAT Spelling	−0.15	−1.06	−0.05	−0.95
WRAT-3 Spelling	−0.16	−1.55	−0.02	−0.83
Real Word Reading Efficiency	−0.58	−1.71	−0.16	−2.45*
Nonword Reading Efficiency	−0.76	−2.93**	0.03	0.46

* $p < .05$ ** $p < .01$

as much instructional intervention. Clearly, severity of reading disability, as well as intensity and duration of treatment, affect learning outcome for remedial instruction.

At least four factors may help to explain the lack of treatment-specific effects for structural analysis training in the group analyses. First, due to small sample size (10 in each treatment group), we may have lacked sufficient power to detect treatment effects. The enormous within-group variation, reflected in the standard deviations, rendered the group effect statistically nonsignificant. Future research might investigate the effect of structural analysis training in larger samples or more homogenous samples.

Second, although the treatments were equally effective at the group level, the trends noted in the individual HLM growth curve analyses suggest that the group difference might have been apparent if the intervention had continued for a longer time (e.g., 64 instead of 16 sessions). The lessons designed by Henry are intended as 30–45 minute group lessons that extend over the school year. In our study students enjoyed one-on-one instruction and frequent opportunities for active participation but spent only 15 minutes a day on structural analysis. Clearly, further research with increased intensity and duration of intervention is needed for this hypothesis to be explained.

Third, the study skills treatment, which was linked to what children did at school, might have helped them to better organize themselves at school and thus benefit more from their regular program, even if it did not teach word recognition explicitly. Students in the upper elementary and middle school grades may benefit from explicit instruction in self-regulation and executive functions as well as in word recognition.

Finally, many of these students had not yet mastered beginning word recognition skills (phonological awareness and orthographic knowledge, knowledge of spelling-phoneme correspondence in the alphabet principle, and application of the alphabet principle to phonological decoding). In many cases, they may not have received systematic, explicit instruction in these skills during the primary grades due to the prevailing whole-language philosophy. Because training in beginning skills was not withheld from any participant, both on ethical and theoretical grounds (advanced skills build on beginning skills), results may indicate that all underachieving readers in the intermediate grades may benefit, to some degree, from the focused instruction on beginning skills. Again, a tutorial of longer duration may have revealed more robust evidence of the benefit from structural analysis in addition to alphabet principle, the cornerstone of beginning skills. Alphabet principle is a powerful component of word recognition; orthographic and phonological awareness support its acquisition and phonological decoding supports its application. However, the trend toward more individual treatment responding for word learning in the Structural Analysis Group, which would not have been found without the multilevel features of HLM growth curve analysis, suggests that children can benefit from structural analysis training before they master the alphabet principle. For this reason, instruction that focuses on all the beginning skills of learning to read (including alphabet principle and phoneme segmentation) and on structural analysis (including syllable structure and morpheme patterns) is recommended for older, underachieving readers, even if the benefits of combined alphabet principle and structural analysis training are not immediately apparent.

That RAN for letters was the only individual difference variable that predicted the slopes of the growth curve for any measure (real word efficiency) lends credence to the claim that the instruction these students were getting at school was not matched to their instructional needs. Earlier in the students' development, other individual difference variables may have exerted constraints on their reading acquisition, causing them to get off to a slower start. In another study with second graders, individual differences in RAN, phonological awareness, and orthographic processing predicted slopes of growth curves in response to intervention (Berninger et al. 1999). As students get older and gain reading skill, many of these individual difference variables may cease to be such major obstacles to learning. At this stage, instructional variables may be more important and continuing, explicit instruction in word recognition may be critical to students' success.

Even though Verbal IQ may set some limits for reading achievement level (pretreatment intercept), in this study it did not significantly influence rate of response (slope) to short-term intervention. Explicit instruction benefited all the children on multiple outcomes (see table IX). Results show that with systematic, short-term intervention, upper elementary and middle school students can keep moving up the reading continuum. Only longer term interventions, integrated with the children's regular and special programs at school, will show just how far up the reading continuum these students, who still require explicit instruction in word recognition, may advance.

APPENDIX

Part I. Alphabet principle training organized by order of predictability.

Order 0-a		Order 0-b	Order 1	
a (apple)	m (mountain)	c (cat)	bl (blocks)	pl (plant)
b (balloon)	n (numbers)	c (circle)	br (bread)	pr (presidents)
d (dog)	p (pumpkin)	g (girl)	cl (clock)	qu (question)
e (exit)	r (rocks)	g (giraffe)	cr (crayon)	sm (smoke)
f (fish)	t (ten)	s (sun)	dr (drum)	sn (snow)
h (hamburger)	u (umbrella)	s (eyes)	fl (flag)	sp (spoon)
i (insect)	v (valentine)	y (yoyo)	fr (frog)	st (stamp)
j (jet)	w (window)	y (fly)	gl (glasses)	sw (swan)
k (kite)	z (zebra)	o (dog)	gr (grapes)	tr (triangle)
l (letters)		o (octopus)	sc (scarf)	tw (twelve)
			sk (skeleton)	x (box)
			sl (sleep)	ck (truck)

Order 2	Order 3		Order 4	Order 5
a.e (ace)	sh (shoes)	oi (oil)	oa (boat)	el (elephant)
i.e (ice)	au (auto)	wh (wheel)	ow (window)	il (pill)
o.e (rose)	aw (claw)	oo (books)	ai (bandaid)	il (child)
o (volcano)	ch (chair)	oo (moon)	ay (play)	all, al (ball)

(continues)

Part I. (*continued*)

Order 2	Order 3		Order 4	Order 5
u (music)	ng (sing)	th (three)	ea (eagle)	ull (bull)
y (baby)	ow (owl)	th (feather)	ea (bread)	ul (ruler)
	ou (house)	ph (phone)	ee (sleep)	ol (sold)
	oy (boy)		ie (tie)	

Order 6	Order 7	Order 8 (schwa)	Order 9 (open syllable)
ar (dictionary)	ight (light)	a (bal*a*nce)	a (apron)
ar (star)	gh (eight)	e (elev*e*n)	e (equal)
er (letter)	gh (laugh)	o (mother)	i (dinosaur)
ir (girl)	dge (bridge)		
or (horse)	tch (watch)		
ur (church)	wr (wrench)		
kn (knife)			
mb (comb)			

Part II. Pages from published programs used in each lesson.

Lesson	Henry's Word Program	Drumm's Study Skills Program	Englemann's SRA Decoding Program
1	15-17	17-20	22-23, 28-29
2	18-19	21-26	63-64, 67-68
3	20-22	75-79	73-74, 75-76
4	23-24	80-85	95-96, 97-98
5	25-27	86-89	1-2, 3-4
6	28-30	90, 92-94	9-10, 11-12
7	31-32	38-42	83-84, 85-87
8	33-35	43-45	88-89, 90-91
9	36-38	61-65	17-18, 19-20
10	39-41	66-68	21-22, 23-24
11	42-44	95-99	33-34, 35-36
12	45-46	100-104	37-38, 39-40
13	47-48	90-92	110-111, 112-113
14	49-51	93-95	120-121, 131-132
15	52-55	96-100	145-146, 147-148
16	56-60	101-105	149-150, 153-154

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