

# The Effectiveness of a Color-Coded, Onset-Rime Decoding Intervention with First-Grade Students at Serious Risk for Reading Disabilities

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This study was an investigation into the effectiveness of a color-coded, onset-rime-based decoding intervention with first-graders at serious risk for reading disabilities using a single-subject multiple probe design. Students increased their ability to decode instructional words on average 73% over baseline. For novel words from instructed rime patterns, scores increased by an average of 56%. Transfer at the vowel level to uninstructed rime patterns was limited, with scores improving by an average of 29%. Students maintained decoding gains at 1-week and 1-month maintenance. While acknowledging the difficulty in predicting reading disabilities based on first-grade performance, the effectiveness of the early intervention is a promising step in finding an instructional approach that is successful with the most at risk or disabled students who often do not respond to effective remedial programs.

Learning to read is a prerequisite for success in our literate society. However, for a significant number of young children, mastering the initial skills of decoding is difficult. Beginning readers who are poor decoders usually continue to fall behind in reading, which negatively affects their overall academic performance, self-esteem, and motivation (Elbaum & Vaughn, 2003; Snow, Burns, & Griffin, 1998). Unfortunately, currently accepted remedial approaches to decoding instruction, although successful for the majority of learning disabled or at-risk readers, fail to significantly improve the skills of a sizable number of readers (Lovett, Warren-Chaplin, Ransby, & Borden, 1990; Torgesen, Wagner, & Rashotte, 1997a). In a study with severely at-risk kindergarten children (bottom 12% in phonological processing skills) who received 46.7 to 48.1 hours of tutorial instruction, Torgesen et al. (1999) reported that, although the scores of children in the most effective condition were within the average range on all reading measures, there was still a substantial proportion of children whose word-level reading skills did not improve. Such results suggest a need for a different instructional approach with the most at-risk or disabled readers, who are often nonresponders to generally effective remedial instruction.

Most research investigating effective remedial decoding instruction over the past 20 years has involved phoneme-level instruction (Ball & Blachman, 1991; Bradley & Bryant, 1983; Torgesen, 2001; Torgesen, Wagner, Rashotte, Alexander, & Conway, 1997b; Vellutino, Scanlon et al., 1996). The focus on phoneme-level instruction results from consensus in the field that children with reading disabilities typically have weak phonemic awareness (Blachman, 1994; Bradley & Bryant, 1978, 1983; Share, 1995; Torgesen et al., 1997a). However, a number of researchers (Haskell, Foorman, & Swank, 1992; Levy & Lysynchuk, 1997; Lovett, 1991; Peterson & Haines, 1992) suggested that, because dif-

ficulties with phoneme level subword and subsyllabic units may be central to the word recognition failures of readers with dyslexia, researchers should investigate the relative effectiveness of remedial reading instruction at subword levels other than the phoneme, such as the onset-rime level.

In accord with that suggestion, using a single subject design across first-grade participants, I investigated the effectiveness of an instructional program emphasizing rimes or word families rather than grapheme-phoneme relationships. The program also incorporated a color-coding system to visually emphasize the rime patterns for additional decoding support. Although the first-grade participants in the study were not identified as learning disabled, due in part to their young age and lack of school experience, they were selected because of their high-risk status based on screening performance and teacher recommendations.

## Onset-Rime Instruction

### *Definition of Onsets and Rimes*

Onsets and rimes are composed of individual phonemes. An onset in a syllable is the initial consonant(s) (e.g., the *c* in *cat*); the rime comprises the vowel and consonants that follow (e.g., the *at* in *cat*). Traditional or synthetic phonics instruction requires the matching of graphemes to phonemes, and then the sequential blending of those individual phonemes into words; when encountering an unknown word *hat*, a child would identify and blend the individual phonemes /h/, /a/, and /t/ into *hat*. Onset-rime instruction, on the other hand, involves the analysis and substitution of word parts from known words to unknown ones at the onset-rime level; when encountering the unknown word *hat*, a child would identify the common rime with the known word *cat* and substitute the initial /h/ sound for /c/ to decode (Levy & Lysynchuk, 1997; Goswami, 1993; Savage, Carless, & Stuart, 2003). Onset-rime instruction typically involves the introduction of

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instructional words by rime or word family (e.g., *cat*, *rat*, *bat*, *fat*). As opposed to rhymes, which sound alike but do not necessarily look alike, rimes are consistent both visually and auditorily.

### *Advantages of Onset-Rime Instruction*

There are a number of reasons why initial reading instruction at the rime level may be more successful with students with, or at risk for, severe reading problems than instruction at the phoneme level. One argument relates to the accessibility of the rime. According to Adams (1990), it is relatively easy to break the onset away from the rime, but difficult to break either the onset or the rime into its phonemic components. Difficulty in segmenting phonemes may be because separate sounds merge in words and are not easily identified as individual sounds when listening to speech (Juel & Minden-Cupp, 2000). In contrast, according to Anthony, Lonigan, Driscoll, Phillips, and Burgess (2003), children have a natural ability to hear onsets and rimes.

Another argument supporting initial onset-rime-level instruction for struggling readers relates to the consistency of the rime unit. Although the English language is alphabet driven, with many regular grapheme-phoneme correspondences, the relationship between the spoken and written codes is complex and frequently irregular (Levy & Lysynchuk, 1997). The simple one-to-one correspondence between graphemes and phonemes found in transparent languages like Spanish or German does not apply to written English, particularly at the vowel level. The vowel may change in accord with the final consonant(s) in a syllable (Goswami, 1999; Moats, 2000). Treiman, Mullinex, Bijeljac-Babic, and Richmond-Welty (1995) carried out a statistical analysis of the links between spellings and sounds in CVC (consonant/vowel/consonant) words in English and found that rime units had more stable pronunciations than individual vowel graphemes or initial consonant plus vowel units. Stanbach (1992) analyzed the rime patterns of the 17,602 words in the Carroll, Davies, and Richman (1971) word frequency norms for children and found that all of the 17,602 words can be classified into 824 rimes, of which 616 occur in common rime families. These data support the consistency of the rime unit in typical reading materials children encounter.

The consistency of the rime in relation to the vowel suggests another argument because onset-rime instruction avoids short vowel confusion. One of the most difficult areas of phonics instruction is short vowel mastery. According to Goswami (1993), vowel misreading is twice as prevalent as consonant misreading for beginning readers. Adams (1990) stated that phonic generalizations about the pronunciation of individual vowels and vowel digraphs are “frustratingly unreliable” (p. 320); however, vowel sounds are usually quite stable within rime patterns.

Instruction with onsets and rimes also requires less facility with blending, another stumbling block for children. Rather than having to identify and then blend the phonemes *r-a-t* together to make *rat*, the child only needs to substitute the *r* in *rat* for the *c* in *cat*. O’Shaughnessy and Swanson (2000) suggested that children respond better to remedial strategies that use larger phonological units (i.e., rimes) that reduce

the memory demands of blending sounds together to form words.

Finally, onset-rime instruction as a beginning reading program is in accord with the developmental model of phonological sensitivity proposed by Adams (1990), as well as Goswami (1993), a model supported by the research of Stahl and Murray (1994) and Anthony, Lonigan, Driscoll, Phillips, and Bergess (2003). According to this developmental model, children’s phonemic awareness progresses from larger to smaller linguistic units (i.e., from words to syllables, to onsets and rimes, to individual phonemes). Anthony et al. (2003) suggested that this developmental model of phonological sensitivity be used to design instruction.

The above arguments in support of onset-rime instruction suggest its appropriateness for early intervention. Many researchers stress the importance of early reading intervention (Jenkins & O’Connor, 2002; Torgesen et al., 2001). A number of recent studies have shown that many children identified as at risk for reading failure in kindergarten and first grade and provided with effective instruction developed proficient reading skills. Torgesen et al. (2001) reported that effective early intervention programs have the capacity for reducing the expected incidence of reading failure from 18% to between 1.4% and 5.4%.

### *Effectiveness of Onset-Rime Instruction*

Although research is limited, particularly in the United States, some researchers assessed the relative effectiveness of onset-rime-level instruction in comparison with instruction at other word and subword levels. Research with normally developing beginning readers was inconclusive (Christenson & Bowey, 2005; Haskell et al., 1992; Walton & Walton, 2002), indicating that both grapheme-phoneme-level and onset-rime-level instruction were superior to whole-word instruction.

According to Bruck (1992) it appears, however, that the path to reading achievement may be different for students with or at risk for reading disabilities. She found that, as word recognition improved for children with dyslexia, they acquired appropriate levels of onset-rime awareness but showed persistent deficits in phonemic awareness and in knowledge of spelling-sound correspondence. Researchers looking specifically at the relative effectiveness of onset-rime-based instruction with children with or at risk for reading disabilities generally found support for onset-rime instruction (Levy & Lysynchuk, 1997; Savage et al., 2003; Walton, Walton, & Felton, 2001). Interpretation, however, was compromised by noncomparable interventions, and different amounts of treatment times. In accord with the research with normally developing beginning readers, research involving students with or at risk for disabilities indicates the necessity of knowledge of grapheme-phoneme correspondence for success with rime-based analogy instruction, a view supported by Ehri (1998).

### **Color-Coding of Rime Patterns**

#### *Transfer of Instructional Gains*

Learning words taught during instruction, however, is not the only measure of the effectiveness of an intervention.

According to Share (1995, 2004) instruction must result in children's acquiring access to the code of reading to allow phonological recoding of uninstructed words. Students must acquire what Share calls the "self-teaching" mechanism to transfer knowledge about the reading of instructional words to effectively decode uninstructed words. Acquiring this ability to transfer skills to decoding uninstructed words following reading instruction is a significant problem for students with or at risk for disabilities (Lovett, Barron, & Benson, 2003; Lovett et al., 2000). Therefore, according to Lovett et al. (2003), evaluating the effectiveness of an intervention involving students with reading problems requires measurement of mastery of instructional words as well as transfer effects to decoding uninstructed words.

If onset-rime instruction is an appropriate method to approach decoding instruction for students with serious reading problems due to its assumed accessibility and relative effectiveness, then the onset-rime instructional method must incorporate techniques that encourage children with or at risk for disabilities to draw rime-based analogies to decode uninstructed words. Although research indicated that children with or at risk for disabilities could be taught to successfully use onset-rime analogies to decode, research also indicated that such children often do not do so without instruction encouraging such analysis (Goswami, 1999; Greaney, Tunmer, & Chapman, 1997).

### *Color Coding to Enhance Transfer*

Possibly the limited transfer and failure of students with or at risk for reading disabilities to use analogies about rime units to decode is due to the fact that the rime is not salient enough for them to draw generalizations. One way to improve the effectiveness of onset-rime instruction is to make the rime patterns more explicit with a color-coding system that highlights those pattern similarities.

### *Research on Color-Coding*

Research investigating the use of color cues to improve the achievement of students with learning disabilities is limited and is not definitive regarding its effectiveness. Goodman and Cundick (1976) found color codes effective in teaching Hebrew letters, and Van Houten and Rolider (1990) found that instruction with color coding improved children's ability to identify numbers and learn multiplication facts. Doyle (1982), however, determined that training with color cues did not decrease children's letter reversals. In investigations into the effectiveness of color and onset-rime instruction, Levy and Lysynchuk (1997) found that accenting the rime with red print led to faster learning, but Levy (2001) found that the use of red highlighting of the rime was no more effective than simply blocking the rime unit. She also found that assigning distinct colors to rime patterns did not improve outcomes; however, words color coded by rime were "scattered across the set of 48 items" (p. 371) rather than blocked in color-coded rimes. According to Levy, visual pattern support within the print itself can help struggling readers. She suggested future research investigating the effect of visual support linking the rime to its pronunciation to enhance transfer.

## **Current Study**

In light of the above research and theoretical arguments, I investigated the benefit of onset-rime instruction for fostering mastery and transfer of word reading skills with first-grade students at serious risk for reading failure. Words were introduced by rime pattern with a color-coding system to enhance the salience of the rime and link it to its pronunciation. Each rime pattern was coded a different hue controlled by short vowel (i.e., all short *a* patterns are a different shade of blue; short *e* patterns, a different shade of red). Based on the literature, I expected that the intervention would substantially improve the students' ability to read instructional as well as novel words from instructed rime patterns. I expected much weaker transfer at the vowel level to uninstructed rime pattern words to decode novel words and did not focus on isolation of the vowel. Furthermore, the pronunciation of the vowel is often dependant upon the final consonant in a CVC syllable (Goswami, 1999; Moats, 2000).

The following were the research hypotheses:

1. A color-coded, onset-rime decoding intervention will be effective in improving performance on taught words for students at serious risk for reading disabilities.
2. Students will transfer their ability to decode instructional words to novel short vowel words from instructed rime patterns (near transfer).
3. Students will transfer their ability to decode instructional words to novel short vowel words from uninstructed rime patterns (far transfer).
4. Students will maintain their decoding skills for instructional and transfer words 1 week and 1 month after instruction ends.

## **METHOD**

### **Setting and Participants**

#### *School Setting*

The first-grade participants attended an elementary school in the eastern United States. The school population was predominately middle class (15.2% FARMS) with moderate ethnic diversity (65.3% White, 14.4% African American, 6% Hispanic, and 14% Asian). The total first-grade population was 87 students.

#### *Training Setting*

The training sessions were in an empty classroom down the hall from the first-grade classrooms, limiting distractions and affording privacy to the students. Also, conducting the training outside the classroom helped assure that the training did not generalize to the other participants. The participants and I sat at right angles to one another at a three-cornered table. This arrangement allowed the recording of data without the child being aware of his/her errors.

### Classroom Reading Instruction

The county curriculum for first grade emphasized developing phonemic awareness and phonics skills. The curriculum also included instruction of high-frequency words. Both teachers primarily used a Guided Reading Approach in their classrooms, recording errors as children read leveled books aloud. Phonics was taught directly or incidentally, depending upon the classroom. All of the children had attended kindergarten in the school. The kindergarten curriculum emphasized letter identification, high-frequency words, phonemic awareness, and phonics. Kindergarten phonics instruction introduced consonants, consonant blends, vowels, and vowel combinations according to the published curriculum.

### Participant Selection

Targeted participants were those first-grade students most at risk for reading problems. Parents of all first-graders ( $N = 87$ ) received an introductory letter and informed consent form requesting permission to screen their children for participation in the intervention. A large number of parents (55) did not return the permission slips, possibly in part because the letter and consent form stated that the intervention targeted children at risk for reading problems. Those students who received parental permission ( $n = 32$ ) were screened for participation. The selection criteria were (a) ability to identify 80% of the 24 letter names (upper and lower case) used in the intervention, (b) ability to provide 75% of the 22 consonant sounds for letters included in intervention words, and (c) inability to decode the 44 CVC/CVCC words included in the intervention with accuracy above 15%. Of the children who were granted parental permission, six students were selected for the intervention. The children selected were determined to be among the seven most at-risk first-graders on the basis of screening performance, confirmed by their teachers and school personnel. One child was not selected because he did not have sufficient knowledge of letter names or consonant sounds. All students selected had been referred to the school's pre-referral team. Of the six selected students, one was not included in the final study because of excessive absences from school; another was excluded because winter break temporarily interrupted her intervention. Therefore, four children were participants.

Table 1 presents information concerning the participants' performance on screening measures in relation to the entire sample of first-graders receiving parental permission. The majority of students (28 of 32) who were screened were considered to be at some risk by their teachers. Therefore, comparison data on the entire sample are not reflective of the total first-grade population.

### Participants

John, a male Caucasian, was 6.3 years old in September of first grade. John had been recommended by his first-grade teacher for a pre-referral evaluation because of concerns about his reading progress. As a result, he was receiving

TABLE 1  
Participant Performance on Screening Measures

Variable	John	Tammy	Arthur	Maria	Group $M$ ( $SD$ )
Letter Identification (max = 24)	21	20	20	22	22.47 (1.70)
Consonant Sounds (max = 22)	17	19	20	20	20.25 (2.17)
Instructional Words (max = 44)	2	5	6	6	19.31 (11.69)

Note. Group is students receiving parent permission to participate in intervention for at-risk first-graders ( $N = 32$ ).

10–15 minutes of individualized instruction consisting primarily of flash card drill with high-frequency words four times a week with a para-educator or parent volunteer.

Tammy, a Hispanic female, was 6.1 years old in September of first grade. Tammy's teacher had recommended that she have a pre-referral evaluation due to reading problems and as a result she was also receiving 10–15 minutes of individualized instruction consisting primarily of flash card drill with high-frequency words four times a week with a para-educator or parent volunteer.

Arthur, a male student of mixed race, was 6.3 years old in September of first grade. Due to concerns about his attention and progress in reading and math, Arthur's teacher had sent a request for academic support to the pre-referral team. However, Arthur was not yet receiving any additional instructional support.

Maria, a Hispanic female, was 6.0 years old in September of first grade. Maria had been recommended to the pre-referral team earlier in the school year due to general teacher concerns. However, Maria was not receiving academic support.

None of the 87 students in the first grade had been identified as having a disability under the Individuals with Disabilities Education Act including the four study participants.

## Research Design and Procedures

### Single Subject (Multiple Probe)

The study was a single-subject multiple probe across participants. In multiple baseline designs, experimental control is established by systematically introducing the independent variable into a series of behaviors, conditions, or subjects in a staggered manner. If change in the independent variable only occurs when the intervention is introduced, experimental control is established (Tawney & Gast, 1984). Multiple-probe designs are a variation of multiple-baseline designs during which baseline data are collected intermittently rather than continually.

### Independent Variable and Instructional Materials

The independent variable was a color-coded, onset-rime reading intervention targeting the decoding of short *a* and short *e* CVC/CVCC words. The instructional materials were books

TABLE 2  
Book Titles and Corresponding Rime Words

<b>Dan</b>	<b>Pat</b>	<b>Dad</b>	<b>Pam and Sam</b>
Dan	Pat	Dad	Pam
man	cat	pad	Sam
ran	rat	had	am
van	bat	sad	jam
can	sat	mad	ham
	at	bad	
	Nat		
<b>The Pet</b>	<b>Ben</b>	<b>Ned</b>	<b>Nell</b>
pet	Ben	Ned	Nell
met	ten	bed	bell
get	den	red	well
wet	men	fed	fell
let	pen		tell
bet			
yet			

1–8 of the *Rime to Read* series for beginning readers (Hines & Klaiman, 2002). The books were organized by rime patterns with each pattern coded a different hue controlled by short vowel (i.e., all short *a* patterns are a different shade of blue; all short *e* patterns are a different shade of red). Four rime patterns per short vowel were introduced and practiced in separate books. A list of the titles and rime pattern words from books 1–8 are included in Table 2. The books were organized with a cumulative list of targeted rime words on the left-hand page and story text using new and old rime pattern words on the right-hand page. A limited number of basic sight words necessary to advance the story line were previewed in a box on the right-hand page and provided to the child as required. The final page of each book was a review of all mastered rime family words by pattern without color coding.

The title of each book introduced the main character whose name/identity contained the rime (e.g., *Pat*, *The Pet*). All illustrations on the cover and throughout the books were printed in black and white, with the exception of depictions of the title characters, who were dressed in the same color as the corresponding rime pattern to serve as keywords. When title characters returned in illustrations of subsequent books, they retained their color coding.

### Dependent Variables

There were three dependent variables. The first was the ability to read instructional CVC/CVCC words from the eight short *a* and *e* rime patterns; the second was the ability to read uninstructed short *a* and *e* CVC/CVCC words from instructed rime patterns (near transfer); the third was the ability to read short *a* and *e* CVC/CVCC words from uninstructed rime patterns (far transfer).

### Measures of Instructional Gains

There were three researcher-designed measures, one for each of the dependent variables. Words in all measures were pre-

sented in random order without color coding. The data-collection method was a frequency count scored as to the percentage of words read correctly.

Measure 1 was 20 of the 44 CVC/CVCC included in the intervention materials, randomly selected without replacement. Five versions of the measure were prepared. This measure of instructional words was administered multiple times during baseline, following training to measure instructional gains, and at 1-week and 1-month maintenance.

Measure 2 was eight near-transfer words from instructed rime patterns, one per rime pattern, randomly selected from a list of possible words. Measure 3 was six far-transfer words from uninstructed rime patterns, three short *a* and three short *e* words, randomly selected from a list of possible words. One version of each of these two measures of transfer was prepared. The measures were administered once before the intervention, once following training, and at 1-week and 1-month maintenance.

### Instructional Procedures

Each student was seen individually four or five times a week for instruction. In each session, the child read one of the eight *Rime to Read* books, while the researcher followed a detailed intervention script that included a correction procedure developed specifically for the study. If a child required the correction procedure more than five times in books 1–4, or eight times in books 5–8, the book was reread during the following session. No child read a book more than two times. After completion of a book on a given day, the session ended.

After completion of the short *a* books (1–4), and then short *e* books (5–8), the child read flash cards with the targeted words from the four rime families printed one to a card with color coding. The child was instructed to sort the words into word families, read the words as sorted, and then read the words after shuffling into random order. If the child made an error on any of these tasks, the researcher supplied the correct response. The same sequence was then repeated without color coding. Regardless of performance, this activity was only completed once in the color-coded and once in the black print condition.

Instructional time varied considerably for the four students. John repeated every book and received 16 instructional sessions of approximately 30 minutes each. Tammy and Arthur both repeated one book and received nine instructional sessions of approximately 15 minutes each. Maria never needed to repeat a book and received eight instructional sessions of approximately 15 minutes each.

### Reliability and Validity

#### Inter-Rater Reliability

The administration of baseline and post training measures was audiorecorded. An independent rater listened to and scored 33% of data-collection sessions for the instructional measure, and 100% of the data-collection sessions for the transfer measures. Inter-rater reliability was calculated for each administration and then averaged for each of the three

measures. The following formula was used (Tawney & Gast, 1984):

$$\frac{\text{Lower number of correct responses}}{\text{Higher number of correct responses}} \times 100$$

The reliability was 86% with a range from 67% to 100% for the measure of instructional words, 89% with a range from 75% to 100% for the measure of near-transfer words, and 91% with a range of 67% to 100% for the measure of far-transfer words. The broad range for reliability resulted from the fact that at baseline the children received very low scores on the measures. Therefore, minimal scoring differences resulted in low reliability scores. For example, although the raters scored only one item differently on the measure of instructional words (i.e., 2 versus 3 of 20 words read correctly) the reliability score was 2/3 or 67%.

### *Treatment Fidelity*

Treatment fidelity was measured by audiorecording each session and having an independent rater listen to the first two sessions with participant 1 and then 33% of the subsequent sessions (randomly selected across participants) to determine whether or not the intervention script and correction procedures were followed with fidelity. Treatment fidelity was rated for each selected session using a rubric designed for this purpose. The first two sessions were reviewed immediately to identify any problems with fidelity. Overall fidelity of treatment was 96% on average with a range from 87% to 100%.

## RESULTS

Figure 1 presents the percentage of instructional words correct for each of the four participants on measures administered during baseline, after instruction, and at 1-week and 1-month maintenance. Figure 2 presents the percentage of near-transfer words correct for each of the four participants on measures administered during baseline, after instruction, and at 1-week and 1-month maintenance. Figure 3 presents the percentage of far-transfer words correct for each of the four participants on measures administered during baseline, after instruction, and at 1-week and 1-month maintenance. The results are also presented in Table 3 (instructional words) and Table 4 (transfer words).

### **John**

Regarding instructional words, during baseline John earned a mean score of 4% with a range from 0% to 5% correct. Following the intervention, he received a mean score of 70% with a range from 60% to 80%. His performance was 70% correct at 1-week maintenance and 65% correct at 1-month maintenance. For near-transfer words, John improved his score from 0% at baseline to 50% correct. He also earned this score at 1-week maintenance. At 1-month maintenance, his score improved to 63% correct. For far-transfer words, at baseline John read 0% of the words correctly. After in-

struction, he read 17% of these words correctly. His score improved to 33% at 1-week and 1-month maintenance.

### **Tammy**

Regarding instructional words, during baseline Tammy earned a mean score of 7% with a range from 0% to 15% correct. Following the intervention, she received a mean score of 79% correct with a range from 70% to 85%. Her performance at 1-week maintenance was 75% correct, and at 1-month maintenance was 80% correct. On the measure of near-transfer words, at baseline Tammy read 0% of the words correctly. After the intervention, her score improved to 50% correct. She also earned this score of 50% at 1-week and 1-month maintenance. At baseline, Tammy read 0% of the far-transfer words correctly. After instruction, she read 17% of these words correctly. She maintained her score of 17% at 1-week maintenance and improved to 33% at 1-month maintenance.

### **Arthur**

Regarding instructional words, at baseline Arthur earned a mean score of 12% with a range from 5% to 20% correct. Following the intervention, he received a mean score of 88% with a range of 80% to 90%. His performance at 1-week and 1-month maintenance was 90% correct. At baseline, Arthur scored 0% on the measure of near-transfer words. After the intervention, his score improved to 63% correct. He also earned this score at 1-week maintenance. At 1-month maintenance, his score improved to 75% correct. At baseline, Arthur read 0% of the far-transfer words correctly. After instruction, he read 33% of these words correctly. His score remained at 33% at 1-week and 1-month maintenance.

### **Maria**

For instructional words, Maria earned a mean baseline score of 13% with a range from 5% to 20% correct. Following the intervention, she received a mean score of 91% with a range from 85% to 100%. Her performance at 1-week maintenance was 95% and 1-month maintenance was 85% correct. At baseline, Maria scored 13% on the measure of near-transfer words. After the intervention, her score improved to 75% correct. At 1-week maintenance, her score dropped to 63%, but returned to 75% correct at 1-month maintenance. At baseline, Maria read 0% of the far-transfer words correctly. After instruction, she read 50% of these words correctly. Her score of 50% was maintained at 1-week maintenance and improved to 67% at 1-month maintenance.

## DISCUSSION

### **Intervention Effectiveness**

The results of the study regarding the learning of instructional words were positive for all students. The four

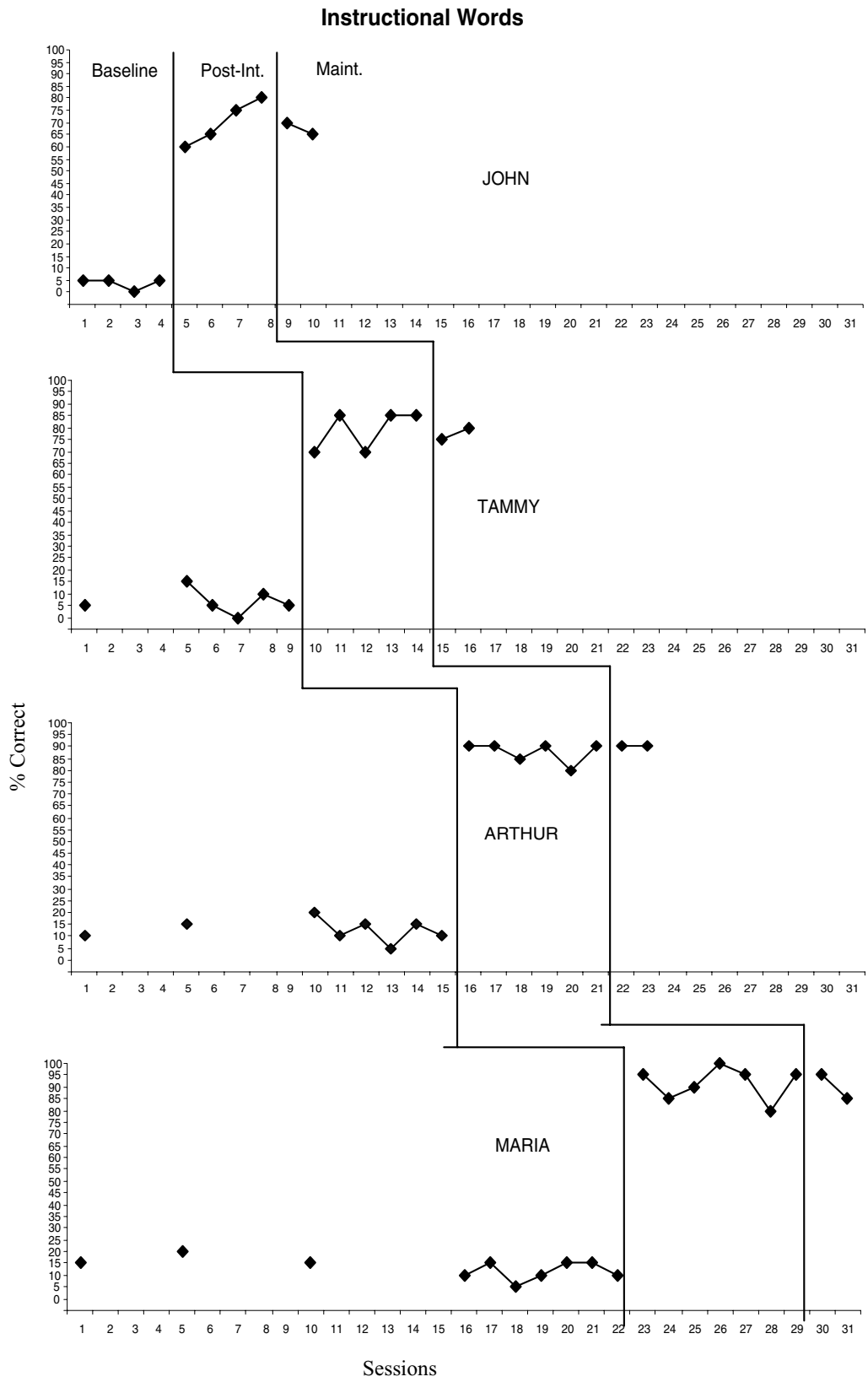


FIGURE 1 Percentage of instructional words correct.

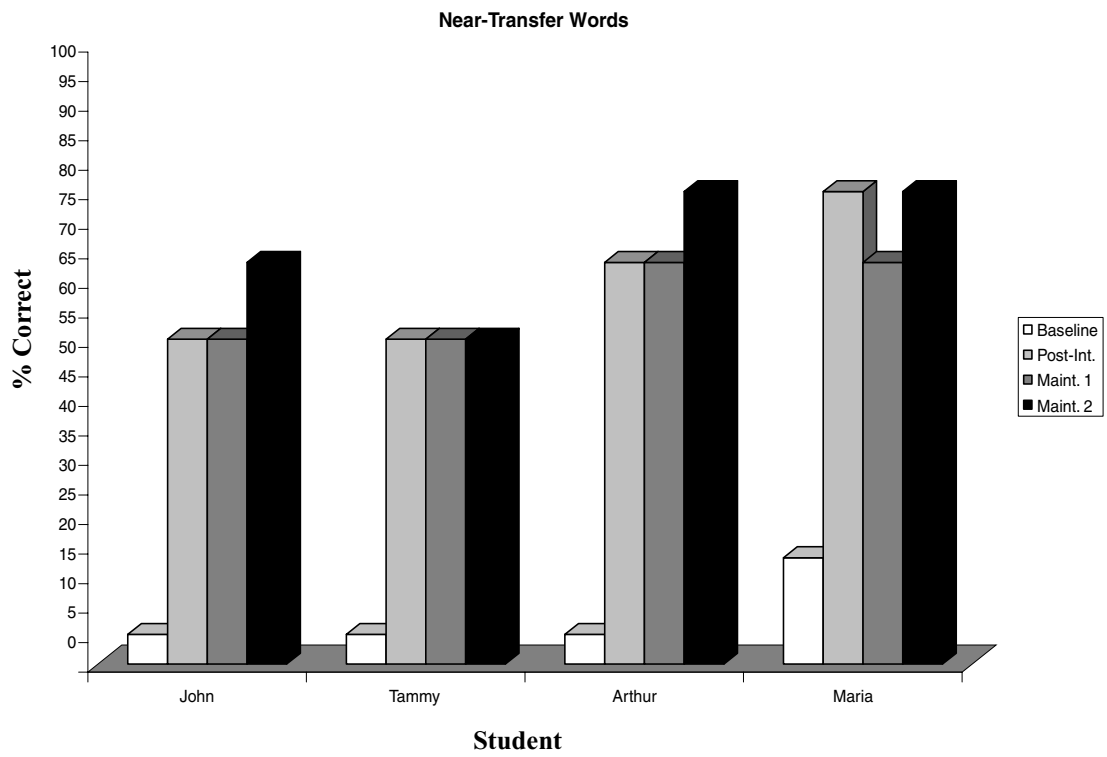


FIGURE 2 Percentage of near-transfer words correct.

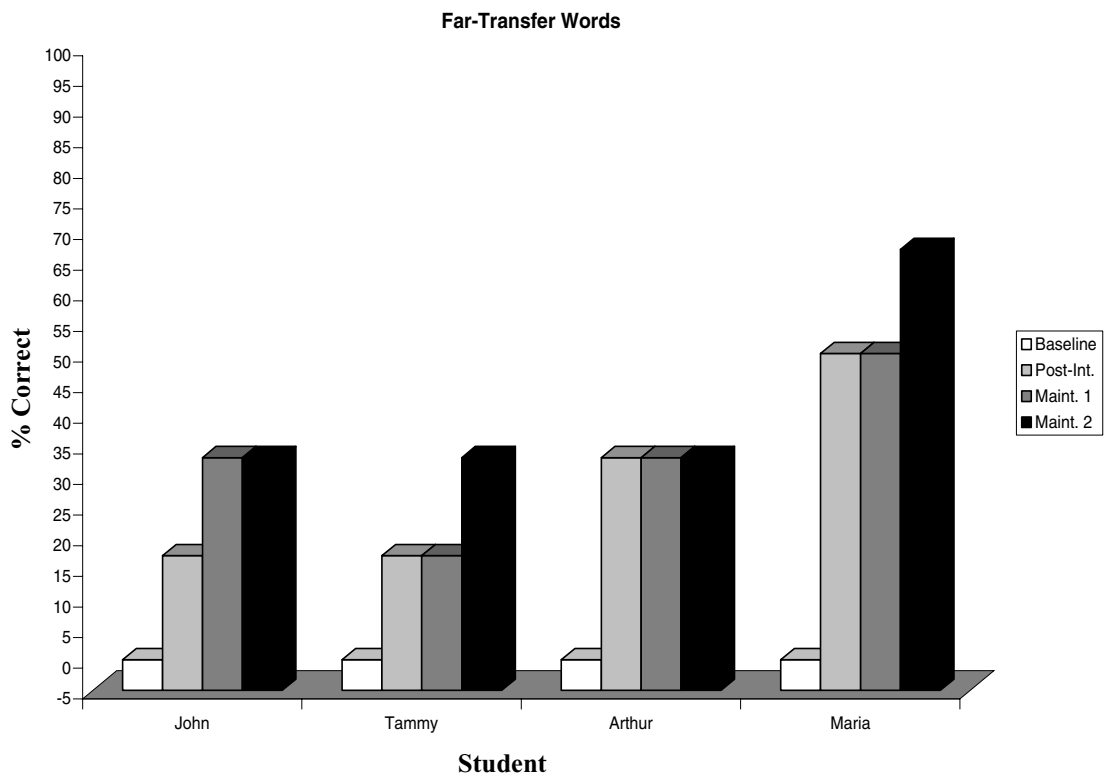


FIGURE 3 Percentage of far-transfer words correct.



TABLE 3  
Instructional Words: Percent Correct

<i>Student</i>	<i>John</i>	<i>Tammy</i>	<i>Arthur</i>	<i>Maria</i>
Baseline	05	05	10	15
	05	15	15	20
	00	05	20	15
	05	00	10	10
		10	15	15
		05	05	05
			15	10
			10	15
				15
				10
Mean	04	07	12	13
Post-Intervention	60	70	90	95
	65	85	90	85
	75	70	85	90
	80	85	90	100
		85	80	95
Mean	70	79	88	91
				80
				95
Maintenance 1	70	75	90	95
Maintenance 2	65	80	90	85

TABLE 4  
Transfer Words: Percent Correct

<i>Student</i>	<i>John</i>	<i>Tammy</i>	<i>Arthur</i>	<i>Maria</i>
	Near Transfer			
Baseline	00	00	00	13
Post-Int.	50	50	63	75
Maint. 1	50	50	63	63
Maint. 2	63	50	75	75
	Far Transfer			
Baseline	00	00	00	00
Post-Int.	17	17	33	50
Maint. 1	33	17	33	50
Maint. 2	33	33	33	67

students increased on average 73% over baseline (range 64% to 78%). The finding that the intervention was effective in teaching instructional words supports results from a number of researchers who found onset-rime-based instruction effective with children with or at risk for reading disabilities (Levy & Lysynchuk, 1997; O'Shaughnessy & Swanson, 2000; Savage et al., 2003; Walton et al., 2001).

The results of this intervention regarding transfer of decoding skills to uninstructed words were also positive for words from instructed rime patterns. Students increased their scores on the near-transfer measure from baseline to post-intervention by an average of 56% (range 50% to 63%). As expected, strong transfer to novel words from uninstructed rime patterns was not found for three of the students. Students improved their scores on the measure of far-transfer words by an average of 29% (range 17% to 50%). The transfer pattern of the four students is consistent with Levy and

Lysynchuk's (1997) finding of transfer to words from instructed rime patterns. It is contradicted by the finding of Muter, Snowling, and Taylor (1994) that children could not decode novel words that shared the rime with a cue word unless the cue word was present.

The student with the strongest transfer of gains to words from uninstructed rime patterns postintervention (50%) was Maria, who achieved one postintervention score of 100% for instructional words. This is in keeping with the research of Levy and Lysynchuk (1997) and Compton et al. (2005), who stressed the importance of mastery learning for acquiring transfer. Possibly transfer would have improved for the other students if the criteria for advancement to the next book had been stricter or if training had continued until they had achieved 100% mastery on probes of instructional words.

The finding that gains for instructional as well as near- and far-transfer words were generally maintained at 1-week and 1-month maintenance is positive and supports the effectiveness of the program. The evidence of strong maintenance is in accord with the findings of Levy and Lysynchuk (1997) that gains from onset-rime instruction were well maintained. This finding of maintenance of gains for instructional as well as transfer words is important given the contradictory findings of Bruck and Treiman (1992) that acquisition of reading skills, although fastest with onset-rime instruction (compared with instruction organized at other subword levels), showed the poorest maintenance of skills.

An interesting finding in this study is that for three of the four students near-transfer scores, and for two of the students far-transfer scores increased between 1-week and 1-month maintenance. Possibly the instructional emphasis on common elements (rimes) and using knowledge of known words to decode unknown words prompted the students to adapt their decoding approach over time and take better advantage of classroom instruction. This explanation is in keeping with the suggestion of Greaney et al. (1997) that children with reading disabilities have the ability to draw analogies to decode successfully but, unlike normally achieving readers, do not spontaneously use that ability.

### Fading of Color Coding

Although the instructional materials were consistently color coded by rime pattern, examiner probes were administered without color coding of the words. There was no systematic fading of the color coding in this study. The children's only encounters with the words without the color codes prior to administration of the probes were when they read the review page of pattern words at the end of each book and when they read the words on flash cards in the black print condition. Because all four participants in this study were able to read the pattern words on the back cover of the book and on the flash cards with few errors, it indicated that fading was not required. The children's performance on examiner probes supported this conclusion. This finding is at odds with the research of Goodman and Cundick (1976), who used color-cues to teach Hebrew symbols and found that a systematic fading procedure was required. However, it is in accord with the research of Van Houten and Rolider (1990), who used

color cues to teach number identification and multiplication facts to students with learning disabilities and determined that fading of the color cues was not necessary.

Possibly a systematic fading procedure was not required in this current study because the intervention script intentionally contained little reference to the color-coding element. The color coding was intended as visual support for categorization and discrimination, rather than as a verbal label. In addition, the use of shades of the same color (e.g., four shades of blue, four shades of red) in the color-coding system did not encourage overreliance on the color cues to identify the word families. In contrast, the colors assigned to symbols in the Goodman and Cundick (1976) study were distinct (e.g., red, green) and the color name was easily substituted for identification of the unfamiliar symbols to name the corresponding nonsense word.

### Amount of Instructional Time and Risk Status of Students

The results are important for two reasons. Of primary importance is the fact that the intervention was effective in teaching instructional words and near-transfer words for all students in spite of their risk status and very weak performance on screening measures. The four participants were among the most at risk of a total school first-grade population of 87 students. In other research with young at-risk populations, Walton et al. (2001) selected the lowest 40% of 77 first-graders, and O'Shaughnessy and Swanson (2000) selected second-graders who scored below the 25th percentile on the Woodcock Reading Mastery Tests-Revised for their study. Levy and Lysynchuk (1997) worked with the lowest 100 of 150 first-grade and kindergarten students, and Savage, Carless, and Stuart (2003) chose the lowest 25% of all first-grade students as participants. The results from the other studies may not represent the performance of children at risk for the most severe disabilities. In addition, the fact that the intervention was effective is important given the total amount of instructional time, which was 2 hours for Maria,  $2\frac{1}{4}$  hours for Tammy and Arthur, and 8 hours for John. Although the intervention was limited to short *a* and *e* rime patterns, the instructional time compares well to that required in other studies (Levy & Lysynchuk, 1997; O'Shaughnessy & Swanson, 2000; Savage et al., 2003; Walton et al., 2001).

### Limitations

A limitation is that I delivered the intervention and collected effectiveness data. Ideally, an individual unfamiliar to the participants would have done data collection. Another limitation is that, due to the multifaceted nature of the intervention, it is impossible to isolate the effectiveness of the individual elements, in particular the color coding. A final limitation is that the study did not offer any information concerning the relative effectiveness of the intervention in comparison with other programs, such as an equivalent program organized at the level of the phoneme.

### Suggestions for Future Research

Future research should evaluate the effectiveness of the color coding. The relative effectiveness of the program in comparison with a program organized at the level of the phoneme should also be evaluated. Future research should also investigate whether the intervention would be more effective if the criterion for advancement to a new book was changed to 100% mastery (Compton et al., 2005; Levy & Lysynchuk, 1997) and/or books could be repeated more than once. Another area for future research is an investigation of the effectiveness of the program with older students identified as learning disabled rather than at-risk first-graders. Future research should also determine if the program would be equally effective if expanded to include rime patterns from all five short vowels rather than just *a* and *e*. Finally, the effectiveness of the intervention in a small group format to improve instructional efficiency should be evaluated.

### Implications for Practice

The study demonstrated the importance of instructional pace on the success of children most at risk for reading disabilities. John, who appeared to be the most at-risk student at baseline, required approximately four times more instructional time (8 versus 2 or  $2\frac{1}{4}$  hours) than the other students to move through the sequence of books. Had he not been allowed to learn at this pace, his progress might have been much less.

The intervention procedure could be adapted in a number of ways in response to student performance. As discussed above, multiple repetitions of books and flash card words could be allowed. In addition, to improve transfer at the vowel level, another step could be added. A possible additional instructional approach is a word ladder with changes to the onset, to the final consonant, and to the vowel (e.g., bat, rat, ran, run) as used by Hines, Speece, Walker, and DaDeppo (2007).

Finally, and most important for research and practice, the study indicated that first-graders at serious risk for reading problems can make progress in acquiring beginning reading skills given relatively short-term, one-to-one instruction using a color-coded, onset-rime approach. This is important given previous findings that the most at-risk and disabled students often do not respond to remedial programs proven effective with less at-risk students. Recognizing that early identification of students with learning disabilities is plagued by over- and underidentification, the effectiveness of the program with significantly at-risk first-graders in a typical elementary school is a promising step in finding an approach to decoding that is successful with the students who have traditionally been left behind not just by traditional classroom instruction but by remedial approaches as well.

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