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Fluency Training in Phoneme Blending: A Preliminary Study of Generalized Effects

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Abstract

We examined the generalized effects of training children to fluently blend phonemes of words containing target vowel teams on their reading of trained and untrained words in lists and passages. Three second-grade students participated. A subset of words containing each of 3 target vowel teams (*aw*, *oi*, and *au*) was trained in lists, and generalization was assessed to untrained words in lists, trained and untrained words in target passages, and novel words in generalization passages. A multiple probe design across vowel teams revealed generalized increases in oral reading accuracy for target words presented in both lists and passages for all 3 students on 2 vowel teams and for 1 student on all 3 vowel teams. Generalized increases in oral reading fluency in both lists and passages were found for all 3 students on the vowel team that was trained to a fluency criterion, with two students showing increases prior to training on the other two vowel teams. Implications of these results for building fluency in prerequisite phonemic awareness skills as an intervention for promoting generalized oral reading fluency are discussed.

Introduction

Phonemic awareness is widely recognized as an important prerequisite skill for proficient reading (Ehri et al. 2001; Snow et al. 1998). Phonemic awareness refers to the ability to identify and manipulate units of spoken language (i.e., phonemes) that are combined to form syllables and words. Although children typically acquire phonemic **[end of page 16]** awareness through early literacy experiences at home, many do not and therefore are at risk for later reading failure (Snow et al.). For these children, explicit instruction in how to identify the separate phonemes of spoken words (segmentation), say words with specific phonemes removed (deletion), or blend sequences of phonemes to form words (blending) is needed to promote phonemic awareness.

In 2000, the National Reading Panel conducted a meta-analysis examining the effects of explicit instruction in phonemic awareness on phonemic awareness, reading, and spelling outcomes (Ehri et al. 2001). A total of 52 studies employing an experimental or quasi-experimental design with a control group met criteria for inclusion in the analysis. The overall effect size (ES) of instruction in phonemic awareness on phonemic awareness skills like segmentation, deletion, and blending was large at .86. Overall ESs on spelling (.59) and reading (.53) were moderate, with effects on reading assessed using tests of word and nonsense word reading as well as reading comprehension.

Despite the importance of phonemic awareness for later reading proficiency, we could find no studies that examined the generalized effects of phonemic awareness training on fluent passage reading, and only two studies that looked at generalized effects on fluent word list reading (Duhon et al. 2010; Thaler et al. 2004). After providing students with daily practice on a pool of 32 words, Thaler et al. found no evidence of generalized fluency gains on words containing identical onset consonant clusters. Similarly, after increasing students' letter-sound fluency, Duhon et al. found limited to no evidence of generalized fluency to letter-sound blending without specific generalization programming. Oral reading fluency or translating connected text with speed, accuracy, and prosody is also an important component of proficient reading, develops subsequent to phonemic awareness, and is essential to reading comprehension (Kuhn et al. 2010; National Reading Panel 2000; Snow et al. 1998). Cognitive models of competent reading characterize oral reading fluency as an important link between word decoding and passage comprehension as it is believed to lighten the burden on working memory (Chard et al. 2002; LaBerge and Samuels 1974). Behavioral models characterize oral reading fluency as the development of stimulus control by printed words and letters. Once developed, stimulus control allows for generalized responding to classes of words that share

common features and application of fluent reading for comprehending text (Codding and Poncy 2010; Daly et al. 2007).

A variety of strategies have been examined in the literature for promoting the generalization of oral reading fluency from trained to untrained passages. Included among these are repeated readings (RR) of the same passage with or without prior modeling (e.g., listening passage preview [LPP]), reinforcement for reaching a fluency goal, training on easier or instructionally matched passages, sequential training on high-word-overlap (HWO) passages, and training using multiple exemplars of either passages or sentences (e.g., Ardoin et al. 2007; Bonfiglio et al. 2004; Daly et al. 1999, 2005; Martens et al. 2007; Silber and Martens 2010). For example, Daly et al. (1999) conducted a brief experimental analysis of instructional components required to produce clear and immediate improvements in oral reading fluency on both trained and untrained HWO passages. Instructional components were combined sequentially for each of four student participants and consisted of **[end of page 17]** reinforcement for rapid reading, RR, LPP/RR, and application of LPP/RR to an easier passage. If generalized increases in HWO passages were not observed, intervention components were applied sequentially to both the trained and HWO passages. Results showed that sequential application of LPP/RR to the HWO passages was required in order to see fluency gains on these passages for all but one participant who showed generalized gains when instructed on easier material.

Martens et al. (2007) evaluated the direct and generalized effects of a fluency-based, after-school reading program with 30 low-achieving second- and third-grade students. Training components included LPP/RR and phrase drill error correction along with goal setting, reinforcement, and charting of performance gains. In order to advance to more difficult passages both within and across grade levels, students were required to reach a retention criterion of 100 words correct per min (WCPM) in the absence of practice 2 days after training. Students who regularly met criterion (i.e., treatment responders) required fewer trainings to master each subsequent passage and often read the next more difficult passage in the curriculum above criterion after training on the previous passage (i.e., showed generalized fluency gains). Generalization to untrained passages at three different grade levels was also assessed following completion of the 5-week program. Results showed statistically significant gains on five of the six untrained passages for the treatment groups but on only one of the six passages for the control groups across grade levels.

In a study that directly compared two generalization strategies, Ardoin et al. (2007) compared RR of one passage four times to RR of each of two passages two times on students' generalized oral reading fluency to a third, untrained passage. The latter condition constituted a form of multiple exemplar training in that students practiced reading two passages rather than one. Six third-grade students participated, and each received training on 12 sets of passages. Although the percentage of overlapping words between the three passages in each set was calculated, it was not controlled for in the study. Results indicated that RR of one passage four times produced greater generalized gains than the multiple exemplar condition for three of the six participants. Results for the other three participants with regard to generalized oral reading fluency were inconclusive. The authors attributed the superiority of the RR condition to the development of strong stimulus control at the word level that resulted from reading the same passage four times.

Although phonemic awareness training has the largest effect on reading outcomes for preschool-age children (d = 1.25 vs. .48 and .49 for students in kindergarten and first through sixth grade, respectively), Ehri et al. (2001) argued that it may also be an effective intervention for older children or those with disabilities who lack prerequisite skills for fluent reading. Along these lines, the National Reading Panel (2000) concluded that, ''fluent and automatic application of phonics skills to text is another critical skill that must be taught and learned to maximize oral reading and reading comprehension'' (p. 11). Phonemic awareness instruction is expected to contribute to the fluent reading of connected text through (a) *reading by analogy*, which involves rapid onset-rime segmentation and blending to relate unknown words by analogy to known sight words, and (b) rapid *decoding*, which involves the blending of graphemes into words (Ehri et al. 2001; Ehri and **[end of page 18]** Robbins 1992). Consistent with the former hypothesis, Mesmer et al. (2010) used an analogy-based phonics procedure to increase the accuracy with which four second-grade students with reading disabilities read trained and untrained (generalization) words. During training, the experimenter modeled pronunciation of a word from a specific rime family (e.g., *ten* from the *en* rime family), described how a second word from the same family was similar (e.g., *pen*), and then had students practice reading the words with corrective feedback. The common rime of each word in a family was color coded. Immediately after training, students were assessed on both trained and untrained words from each rime family but without the benefit of the color cue. All four students increased their accurate reading of trained words, and three of the four students showed generalized increases to the untrained words. When assessments were repeated with the color cues added, additional increases were observed in the accurate reading of generalization words for all four students. Consistent with the latter hypothesis, Daly, Chafouleas, Persampieri, Bonfiglio, and LaFleur (2004) taught two first-grade students with reading problems lists of nonsense words using

either a phoneme segmenting and blending strategy or a sight-word strategy. In the phoneme segmenting and blending condition, students were prompted to read each phoneme in a nonsense word individually and then blend the sounds to make the whole word with modeling and corrective feedback. In the sight-word condition, students were prompted to read the whole nonsense word, again with modeling and corrective feedback. Generalized effects of both training conditions were assessed by having the children read real words that were similar to the trained nonsense words. Results showed that both students were able to correctly read more real (generalization) words in the phoneme segmenting and blending condition.

Purpose of the Study

Although Daly et al. (2004) showed that training in segmenting and blending of nonsense words can produce generalized increases in the *accuracy* with which students decode real words, generalized effects of phoneme blending training on students' oral reading *fluency* (either on word lists or on passages) were not assessed, nor were students trained to decode words fluently. The present study attempted to address these limitations in three ways. First, we added a fluency-building component to our phoneme blending training procedure by reinforcing both accurate and rapid blending of words containing target vowel combinations. Second, we examined the generalized effects of training on students' reading of trained, untrained, and novel words containing the target vowel teams presented in both lists and passages. Third, we assessed generalized improvements in students' reading along two dimensions, oral reading accuracy and fluency. The study was considered preliminary because we trained only three skills (i.e., fluent blending of words containing three specific vowel teams) and assessed generalization using tightly calibrated word lists and passages. Nevertheless, results of the study were expected to shed light on the potential for fluency training in phoneme blending to promote generalized reading gains. **[end of page 19]**

Method

Participants and Setting

Three second-graders from different general education classrooms in an urban, Central New York elementary school participated in the study. The students were recruited because they were performing at the frustrational level in oral reading fluency for their grade based on school-wide DIBELS screening (i.e., reading less than 40 WCPM). Ian, an African American male, began the study reading 28 WCPM on DIBELS materials and 52 WCPM on second-grade AIMSweb reading material. Dante, an African American male, began the study reading 25 WCPM on DIBELS materials and 40 WCPM on second-grade AIMSweb materials. Fern, a Hispanic female, began the study reading 30 WCPM on DIBELS materials and 29 WCPM on second-grade AIMSweb materials. Additionally, these students were included based on their inability to correctly pronounce the vowel teams *aw*, *oi*, and *au* presented in isolation and in 50 % or less of words during screening.

All screening, training, and testing sessions were conducted with each student individually at one of three round tables in a quiet section of the school library. Three doctoral-level school psychology graduate students served as experimenters. The experimenters had prior coursework and training in curriculum-based measurement and practiced the word list phoneme blending training and passage assessment protocols before the study began. Word list training sessions were conducted 3 days a week on Mondays, Wednesdays, and Fridays and lasted approximately 15 min each. Passage reading sessions were administered on three consecutive school days lasting about 10 min each.

Materials and Assessment Procedures

Vowel Team screening

Prior to the start of the study, students were screened to assess their accuracy in recognizing the sound(s) associated with 15 vowel teams ''ee,'' ''oa,'' ''ai,'' ''ea,'' ''oe,'' ''ie,'' ''ay,'' ''ow,'' ''ou,'' ''oo,'' ''aw,'' ''au,'' ''oi,'' ''oy,'' and ''ew'' using a procedure developed for the purpose of this study. Experimenters were equipped with 5 by 7 in. index cards containing each of the target vowel teams, each of four words associated with a vowel team, scoring sheets, clip boards, and pencils. Protocols containing step-by-step instructions were also provided to each experimenter to follow during the screening assessment.

Each child was presented with an index card containing one of the target vowel teams and was asked to ''tell me the sound that these letters make when put together.'' The experimenter recorded whether the student was able to correctly produce the sound associated with the target vowel team on the scoring sheet. No feedback or error correction was provided during this procedure.

Immediately after each vowel team was presented in isolation, the experimenter presented each of four words containing that target vowel team. Words were selected from the phonetically regular word list provided in the Road to Reading **[end of page 20]** series (Blachman and Tangel 2008). The experimenter presented each word one at a time on an index card and instructed the student to ‘‘tell me what word this is.’’ The experimenter made note of correctly read words and phonetically recorded the student’s reading of incorrect words in the space provided on the scoring sheet. Errors included incorrect pronunciation of the word, pausing for more than 3 s on a particular word, refusal to read a word, and asking for assistance from the experimenter.

Curriculum-Based Measurement (CBM) Screening

Also prior to the start of the study, CBM probes were used to identify a common frustrational level for the three students using placement criteria proposed by Fuchs and Deno (1982). Each child was administered three reading probes, each containing between 130 and 150 words. Probes were selected from the AIMSweb database (http://www.aimsweb.com) of CBM reading probes at second-, third-, and fourth-grade reading levels.

According to Fuchs and Deno (1982), students are at a frustrational level when they read less than 40 WCPM with more than 4 errors on a second-grade passage and less than 70 WCPM with more than 4 errors on third- and fourth-grade passages. On the basis of the screening results, second-grade passages were identified as the common frustrational level for all three students.

For the CBM screening, students were given a copy of the passage and asked to ‘‘do their best reading’’ while reading aloud for 1 min. The experimenter recorded the number of words read correctly for each passage by counting the total number of words read in 1 min and then subtracting the number of errors made. Errors included omitting words, saying the wrong word, reading suffixes such as ‘‘-ed’’ or ‘‘-s’’ incorrectly, or pausing for more than 3 s on a particular word and needing assistance from the experimenter (Shapiro 2004). Two copies of each passage were made for each student: an examiner’s copy that included a word count at the end of each sentence and a second copy that did not include a word count that was re-typed verbatim for the students to read. Experimenters were also equipped with pencils and stopwatches for recording purposes. Protocols containing step-by-step instructions were provided to each experimenter to follow during the intervention.

High-frequency Word List Screening

Students’ fluency on lists of known, high-frequency words was assessed to identify a fluency criterion for moving students from word list training to assessment on the target and generalization passages. Words on the high-frequency word list were obtained from the school’s reading specialist and were the words that the students were expected to have mastered in the first grade. Students were presented with a list of 20 high-frequency sight words and instructed to read the list three times as fast as they could with a short break between each reading. The median WCPM across the three readings was taken as each child’s optimal reading rate of known, high-frequency words. Because we were training students to fluently blend unknown words, we arbitrarily set 50 % of this rate with no more than one error **[end of page 21]** as each student’s word list training criterion. The 50 % fluency criterion was set at 42 WCPM for Ian, 40 WCPM for Fern, and 27 WCPM for Dante.

Passage Reading Probes

Eighteen second-grade passages that contained words with the target vowel combinations were selected from the AIMSweb database of CBM reading probes (http://www.aimsweb.com/). These passages were then edited so as to contain a higher percentage of sentences with words containing a target vowel team for use in the intervention and control conditions (i.e., at least 90 % of the sentences in the final passages contained a word with the target vowel combination). For example, a sentence that read, ‘‘Since Joey had no one to play with, he sat on the front steps.’’ was edited to read, ‘‘Since Joey had no one to play with, he sat on the *lawn*.’’

Students were screened on each of the 18 rewritten AIMSweb passages using the CBM screening procedure outlined above. Of these, the 12 passages for which the mean WCPM across students was the most similar were used for the remainder of the experiment. The mean Spache readability level of the 12 experimental passages was 2.8 before editing and 3.0 after editing. Four passages contained words with the vowel combination *aw*, four contained words with the vowel combination *au*, and four contained words with the vowel combination *oi*. For each vowel combination, two passages contained words that were trained and/or assessed in word list training sessions (target passages), and two passages contained words that were neither trained nor assessed in the word list training sessions (generalization passages). The mean WCPM across students at screening, the percentage of sentences containing a word with the target vowel team, the number of unique words containing a target vowel team, and the readability level of each passage are summarized in Table 1.

Table 1 Mean WCPM at screening, percentage of sentences containing a word with the target vowel team, number of unique words containing a target vowel team, and readability of each passage

Vowel team and passage	WCPM	Percentage of sentences	Unique target words	Readability	
				O	R
AW (target 1)	30.8	100	5	2.1	2.6
AW (target 2)	35.4	100	8	2.6	2.8
AW (generalization 1)	32.2	90	6	3.4	3.0
AW (generalization 2)	35.8	91	5	3.3	3.1
OI (target 1)	33.2	100	5	3.2	3.1
OI (target 2)	32.4	100	3	3.2	2.7
OI (generalization 1)	33.0	100	6	2.4	2.6
OI (generalization 2)	33.8	100	6	2.8	3.1
AU (target 1)	36.6	100	5	2.4	3.0
AU (target 2)	27.6	100	7	2.4	3.4
AU (generalization 1)	36.2	100	4	3.2	3.5
AU (generalization 2)	38.8	100	4	2.4	3.4

WCPM words correct per min, *O* original version, *R* revised version

[end of page 22]

Word Lists

One- and two-syllable words that contained the target vowel team being trained in each condition were selected from an online dictionary source (www.morewords.com). Prior to the beginning of training, all words were screened to determine which were known and unknown by the students. To assess for generalization, three different sets of words were compiled for each target vowel team. The first set of words was taken from the target passages and was trained during word list training. These words were used to assess generalization of trained words in target passages. The second set of words included other words from the target passages as well as words that did not appear in any passages. These words were assessed but not trained on word lists and were used to assess generalization of untrained words in target passages. The third set of words was taken only from the generalization passages. These words were neither trained nor assessed during word list training and were used to assess generalization to novel words in generalization passages.

During each word list training session, four words were trained (from Set 1) and these four words plus four untrained words (from Set 2) were assessed. As noted above, words appearing in the generalization passages (Set 3) were never trained or assessed in word lists. Each set of four trained and four untrained words contained a ratio of one known to three unknown words based on the results of screening and previous trainings. The ratio of known to unknown words was rebalanced at the start of each subsequent training session.

Dependent Measures

Accuracy and fluency measures of student performance on both word lists and passages were used as dependent measures in the current study. Fluency measures included WCPM on the list of trained and untrained words administered just prior to each training session and WCPM on the target and generalization passage reading probes. Each word list contained the same words that were trained in the previous session but was administered at the beginning of the next training session to evaluate retention (i.e., a word list retention probe). Accuracy measures included the percentage of correctly read words on the word list retention probes and the percentage of correctly read words containing the target vowel team on both the target and generalization passages.

Experimental Design and Procedures

A multiple probe design across vowel teams was used to assess whether training students to blend phonemes on word lists led to generalized oral reading accuracy and fluency on word lists, target, and generalization passages.

Baseline and Maintenance Passage Reading Probes

The first set of baseline data were taken from the students' oral reading fluency (WCPM) during initial readings of the 12 selected passages. Subsequent **[end of page 23]** administrations of the passage reading probes were originally scheduled to take place at three points during the study, once each time students reached the fluency criterion for

each of the three vowel combinations following word list training. However, over the course of training, we ran out of unknown words from Set 2 to assess during word list training before the students reached criterion (with the exception of *aw* words for Dante and Ian). Dante almost reached criterion also on *oi* words but exceeded the error limit, and Fern almost reached criterion on *aw* words but fell 2 WCPM short. As a result, we administered the passage reading probes when no more word list trainings could be conducted.

Passage reading probes were administered beginning on the same day as the last word list retention probe, and all word list training was suspended during passage probe sessions. To reduce student fatigue, only four passages were probed each day in two sessions. For each passage reading probe, students were given a passage and asked to read orally for 1 min while the experimenter marked WCPM. At the end of the 1-min reading, the experimenter stopped marking WCPM and allowed the student to complete the sentence. Immediately following the first reading, the experimenter repeated the procedure with the second passage, took a brief break, and then repeated the procedure with the third and fourth passages. The same procedure was followed on the next two consecutive days until all 12 passages had been probed. Target and generalization passages were always alternated, and probes were administered in a running sequence of *aw*, *oi*, and *au* beginning with the vowel team that was just trained. Thus, if *oi* was just trained, target and generalization probes were administered in sequence for *oi*, *au*, and *aw*.

Word List Training

Word list training began with the experimenter teaching the rule for saying the vowel combination by presenting the vowel team on an index card and modeling its pronunciation. The student was then required to correctly repeat this pronunciation three times. Students then participated in a blending task using one known and three unknown target words. The experimenter visually presented the sound segments of each word on separate index cards and said, ‘‘These are the sounds …’’ pointing at each segment as it was pronounced. The experimenter then orally blended the word and said, ‘‘When put together these sounds make the word…’’ Index cards containing onset and rime phonemes were white, whereas index cards containing the target vowel combination in isolation or in words were color coded to aid in discrimination of the vowel teams. The experimenter then instructed the student to ‘‘repeat after me: (sound segments here) makes (whole word here)’’ (e.g., the experimenter showed three sound cards containing the sound segments /c/ /l/ /aw/ and said these are the sounds /c/ /l/ /aw/, when put together they make the word ‘‘claw.’’ Repeat after me: /c/ /l/ /aw/ makes ‘‘claw’’). The student was then required to correctly blend the word as demonstrated by the experimenter. If the word was correctly blended, the student was required to repeat the correct blend three times. If the word was incorrectly blended, the experimenter modeled the correct blend again and the student was then required to repeat the correct blend three times. This process was repeated until the student was able to correctly blend the target word **[end of page 24]** three consecutive times. Once students could correctly blend a word, the experimenter moved on to the next word on the word list and repeated the same steps outlined above. This procedure was done for each of the four target words assigned to that particular training session.

Immediately following phoneme blending training, students completed a word list assessment which involved reading the four trained words along with four untrained words from Set 2 containing the same vowel combination. Words were presented in random order on 5 by 7 in. flashcards attached with Velcro© to a black board in two rows of four. The WCPM score achieved during this assessment was used as the ‘‘beat your score’’ contingency during the word list retention probes 2 days later. If students beat their score on the word list retention probe, they were able to pick a small prize from the prize box (e.g., pencils, erasers, etc.).

At the beginning of each training session (with the exception of the first day of training), students were assessed on the same words trained in the previous session. The order of words was randomized. The purpose of this assessment was to determine whether students were able to demonstrate accurate and rapid decoding following a 2- to 3-day retention interval, with 3-day word list retention probes occurring when the session was completed on a Friday. Students were considered to be fluent in using the decoding skill when they were able to read the word list at 50 % of their known high-frequency word list reading rate with no more than one error. Once students met criterion for reading the word list retention probe, they were administered the passage reading probes.

Procedural Integrity and Interscorer Agreement

Procedural integrity was assessed during 100 % of the letter-sound correspondence screenings and during 98 % of all word list training and passage probe sessions. To assess procedural integrity, a second experimenter observed administration of the procedures and scored the percentage of steps completed correctly as the number of correct steps divided by the total number of steps multiplied by 100 %. Procedural integrity was 100 % for letter-sound correspondence screenings, word list training sessions, and passage probe sessions.

Interscorer agreement for WCPM was assessed during 100 % of all letter-sound correspondence screenings on a vowel team-by-vowel team basis and word-by-word basis and calculated as the number of scoring agreements

divided by the total number of agreements plus disagreements multiplied by 100 %. Interscorer agreement for letter-sound correspondence screenings was 99 % (range = 99–100 %). Each experimenter was also assessed for interscorer agreement on WCPM by students on word list retention and passage probes. Interscorer agreement was assessed during 98 % of all sessions by a second, trained observer who scored WCPM during oral readings along with the experimenter. Interscorer agreement for WCPM on word list retention and passage probes was conducted on a word-by-word basis and calculated as the number of scoring agreements divided by the total number of agreements plus disagreements multiplied by 100 %. Interscorer agreement was 99 % (range = 95–100 %). **[end of page 25]**

Results

Generalized Oral Reading Accuracy

Dante, Ian, and Fern's oral reading accuracy during word list training and on passage probes is depicted in Figs. 1, 2, and 3, respectively. The mean percentage of words containing each target vowel combination that was read correctly per condition is reported in Table 2.

As shown in the word list training phases of Figs. 1, 2, and 3, all three students showed increasing trends in accuracy during word list training on the *aw* and *au* vowel teams. However, accuracy levels at the end of training were higher for *aw* words (*M* = 92 %) than for *au* words (*M* = 50 %) across the three students. Dante also showed an increasing trend in accuracy during *oi* training, attaining 75 %

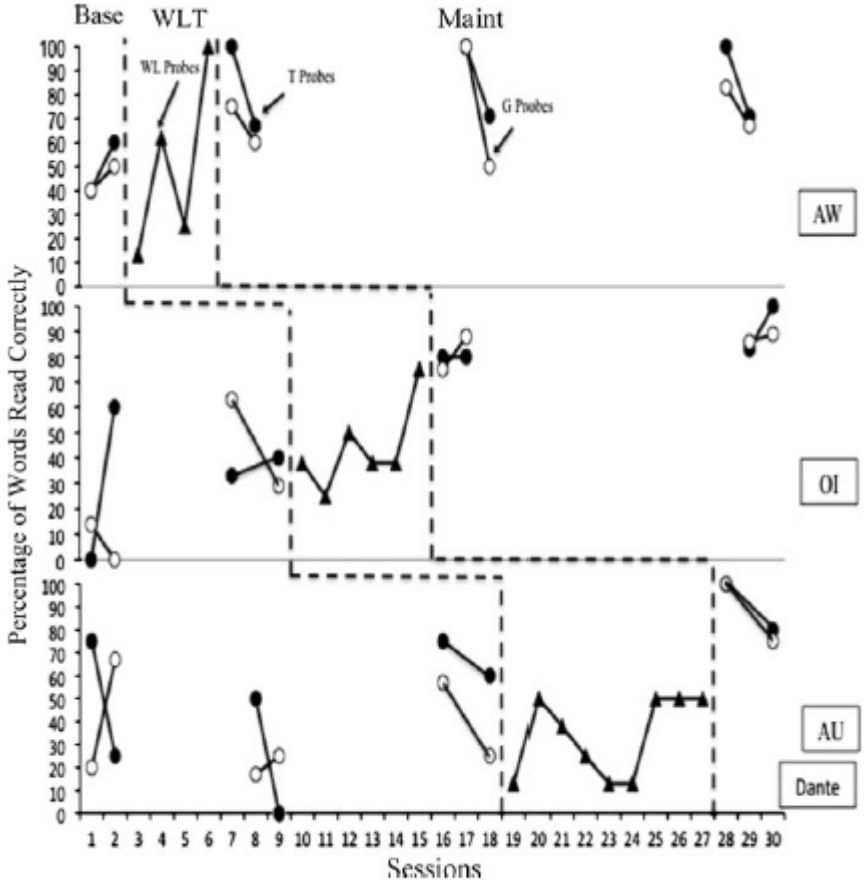

Fig. 1 Percentage of words containing a target vowel team read correctly on word lists and passages across conditions for Dante (*Base* baseline, *WLT* word list training, *Maint* maintenance)

[end of page 26]

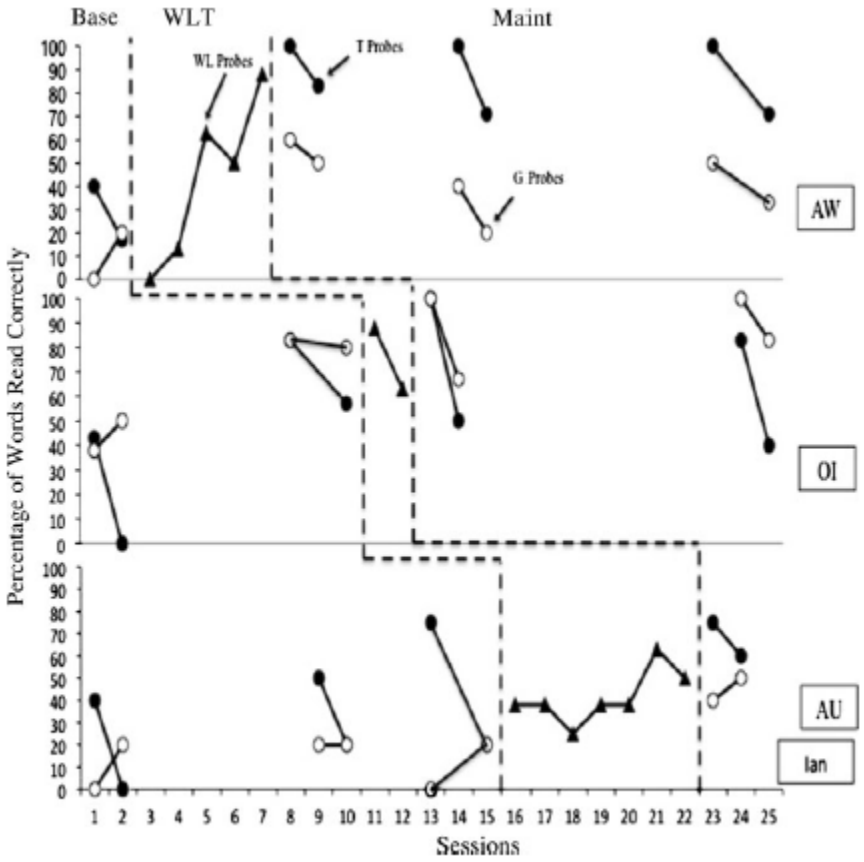

Fig. 2 Percentage of words containing a target vowel team read correctly on word lists and passages across conditions for Ian (*Base* baseline, *WLT* word list training, *Maint* maintenance)

accuracy during the final training session. Because each word list contained a mix of four trained and four untrained (generalization) words, these data suggest that all three students demonstrated some generalized increases in oral reading accuracy to untrained words presented in lists during the retention assessments.

Dante (Fig. 1) showed variable levels of accuracy on the passage probes for all three vowel teams prior to word list training, with means ranging from 7 to 50 %. After word list training on each vowel team, Dante' accuracy increased to levels above those of previous baseline probes (M = 67.5–90.0 %) and remained high during subsequent maintenance probes (M = 75–91.5 %). In addition, Dante showed similar increases in generalized oral reading accuracy on passages containing words previously trained and assessed in lists (i.e., target passages) and passages containing novel words (i.e., generalization passages).

Ian (Fig. 2) also showed variable levels of accuracy during the initial baseline probes, with means ranging from 10 to 44 %. Ian's accuracy levels on the target **[end of page 27]**

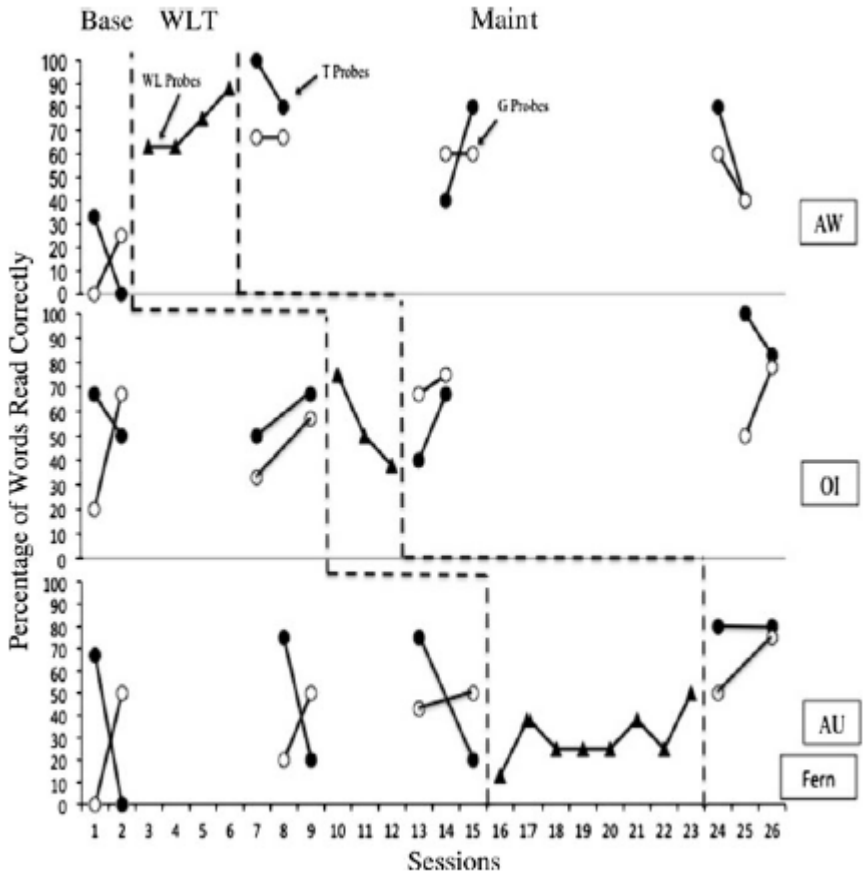

Fig. 3 Percentage of words containing a target vowel team read correctly on word lists and passages across conditions for Fern (*Base* baseline, *WLT* word list training, *Maint* maintenance)

passages increased and remained high after training on the *aw* and *au* vowel teams (*M* = 67.5–91.5 %). Increases in accuracy on the generalization passages for these two vowel teams were smaller although still above pre-training levels. The largest increases in accuracy for the *oi* vowel team coincided with *aw* training, with only modest additional gains occurring after *oi* training. Thus, Ian also showed generalized increases in oral reading accuracy when target words were presented in passages but only for the *aw* and *au* vowel teams and to a lesser extent for novel words that were neither trained nor assessed in lists.

Like the other two students, Fern (Fig. 3) showed variable levels of accuracy on all three vowel teams prior to training (*M* = 12.5–58.5 %). Training in both the *aw* and *au* vowel teams led to immediate increases in accuracy on both the target and generalization passages that were maintained during subsequent passage probes (*M* = 50–91.5 %). Increases in generalized oral reading accuracy for the *oi* vowel team were only observed on target passages and only after training on the *au* vowel **[end of page 28]**

Table 2 Mean percentage of words with target vowel teams read correctly on word lists and passages across conditions

Name	Vowel team/ passage		Base 1	WLT	Base/Maint 2	WLT	Base/Maint 3	WLT	Maint 4
Dante	AW	T	50.0		83.5		85.5		85.5
		G	45.0	50.0	67.5		75.0		75.0
	OI	T	30.0		36.5		80.0		91.5
		G	7.0		46.0	44.0	81.5		87.5
	AU	T	50.0		25.0		67.5		90.0
		G	43.5		21.0		41.0	33.6	87.5
Ian	AW	T	28.5		91.5		85.5		85.5
		G	10.0	42.8	55.0		30.0		41.5
	OI	T	21.5		70.0		75.0		61.5
		G	44.0		81.5	75.5	83.5		91.5
	AU	T	20.0		35.0		47.5		67.5
		G	10.0		20.0		10.0	41.4	45.0
Fern	AW	T	16.5		90.0		60.0		60.0
		G	12.5	72.3	67.0		60.0		50.0
	OI	T	58.5		58.5		53.5		91.5
		G	43.5		45.0	54.3	71.0		64.0
	AU	T	33.5		47.5		47.5		80.0
		G	25.0		35.0		46.5	29.9	62.5

WLT word list training, *T* target passage, *G* generalization passage, *Base* baseline, *Maint* maintenance

team. Similar to Dante, Fern showed generalized increases in oral reading accuracy for trained, assessed, and novel words presented in passages but only for the aw and au vowel teams.

Generalized Oral Reading Fluency

Dante, Ian, and Fern's oral reading fluency results during word list training and on passage probes are depicted in Figs. 4, 5, and 6, respectively. Each student's mean WCPM on word lists and passages is reported in Table 3.

All three students showed an increasing trend in WCPM during word list training for the *aw* vowel team (Figs. 4, 5, 6), with both Dante (30 vs. 27 WCPM) and Ian (53 vs. 42 WCPM) meeting their fluency criterion as indicated by the dashed horizontal line in each panel. Fern came close to meeting her fluency criterion the last day of training (38 vs. 40 WCPM). Data in all other word list training phases were either stable or showed a decreasing trend and fell below the fluency criterion. Viewed in light of the accuracy results, these data suggest that all three students likely acquired the *aw* rule (M accuracy at the end of training = 92 %) and were able to apply this rule to fluently decode both trained and untrained words in lists. In contrast, all of the students were less accurate in decoding lists of words containing the other two vowel combinations, and none of the students met the fluency criterion before we ran out of untrained words to assess. **[end of page 29]**

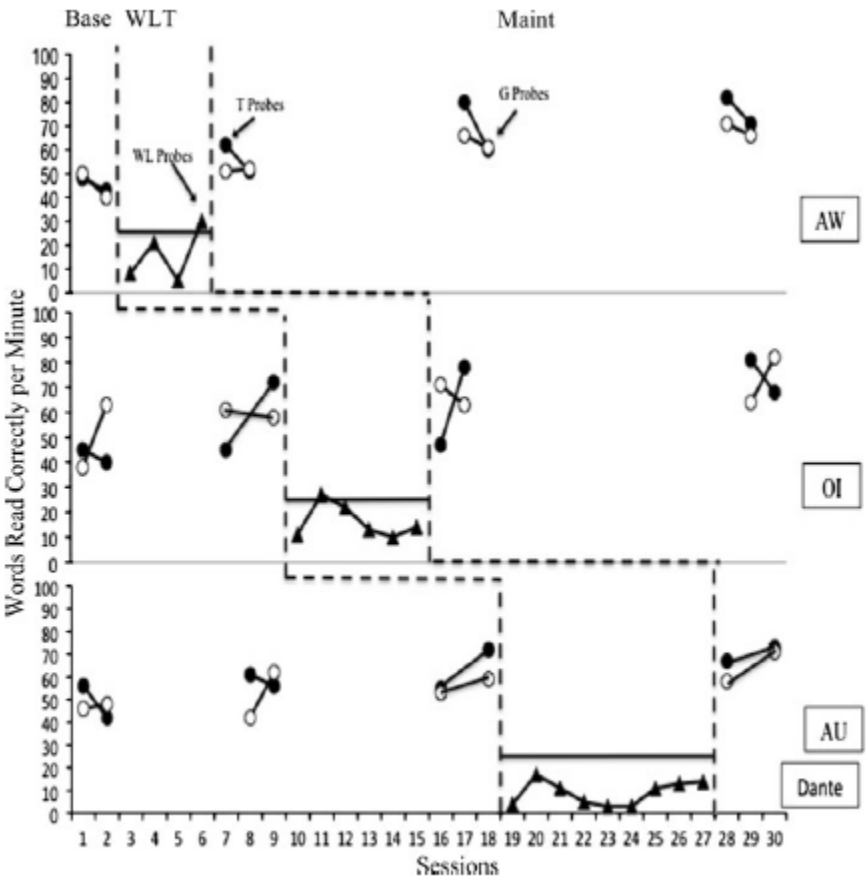

Fig. 4 Words read correctly per minute on word lists and passages across conditions for Dante (*Base* baseline, *WLT* word list training, *Maint* maintenance). The *horizontal line* indicates the WLT fluency criterion

Consistent with the word list training results, all three students showed generalized increases in oral reading fluency to passages after training in the *aw* vowel team (Table 3). These increases were generally comparable on target and generalization passages (with the exception of the third baseline/maintenance probe for Ian) and remained above pre-training levels during subsequent maintenance probes. Thus, generalized increases in oral reading fluency on *aw* word lists were accompanied by generalized increases in the fluent reading of passages that featured trained, assessed, and novel *aw* words. For Dante and Fern, word list training did not lead to immediate generalized increases in oral reading fluency on either the *oi* or *au* passages. Rather, these students showed gradual increases in fluency over repeated administration of the passages, with WCPM during the final maintenance probes being above initial baseline levels. WCPM for Ian on *oi* and *au* passages remained **[end of page 30]**

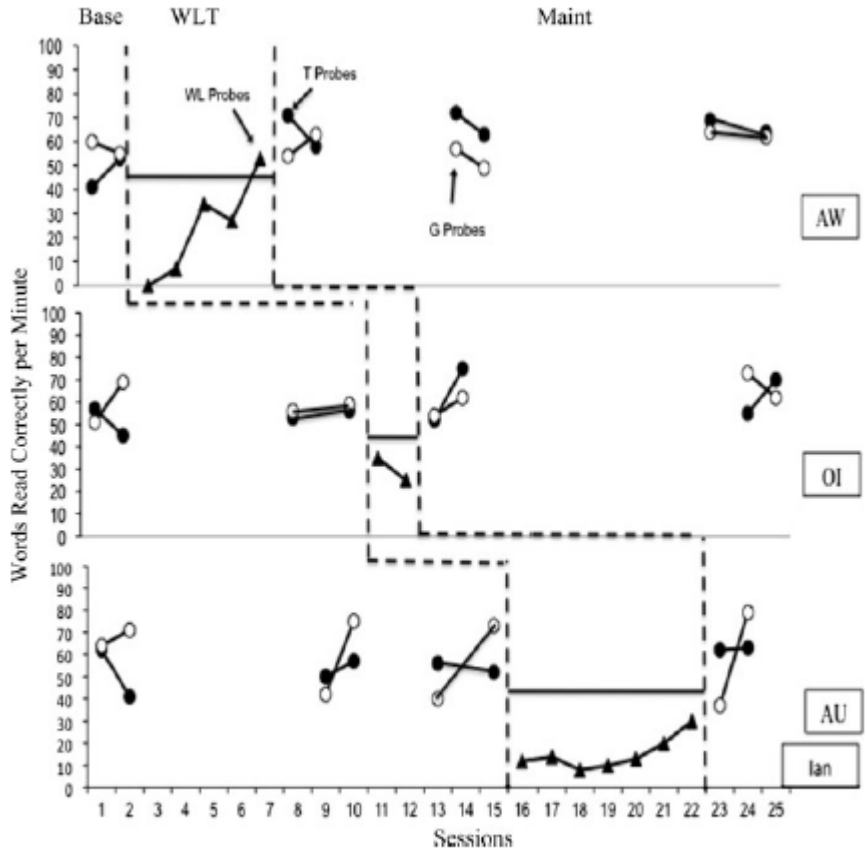

Fig. 5 Words read correctly per minute on word lists and passages across conditions for Ian (*Base* baseline, *WLT* word list training, *Maint* maintenance). The *horizontal line* indicates the WLT fluency criterion

relatively stable over the course of the study despite word list training, suggesting no generalized effects on passages for these two vowel teams.

Discussion

Previous research has shown that training students to blend the sounds that make up nonsense words can generalize to accurate reading of real words (Daly et al. 2004). The purpose of this study was to extend the findings by Daly et al. by assessing the effects of fluency training in phoneme blending on students' generalized oral reading accuracy and fluency. Specifically, we trained students to fluently blend phonemes of words containing target vowel combinations and assessed three levels of generalization: to untrained words on lists, to trained and untrained words in passages, and to novel words in passages. **[end of page 31]**

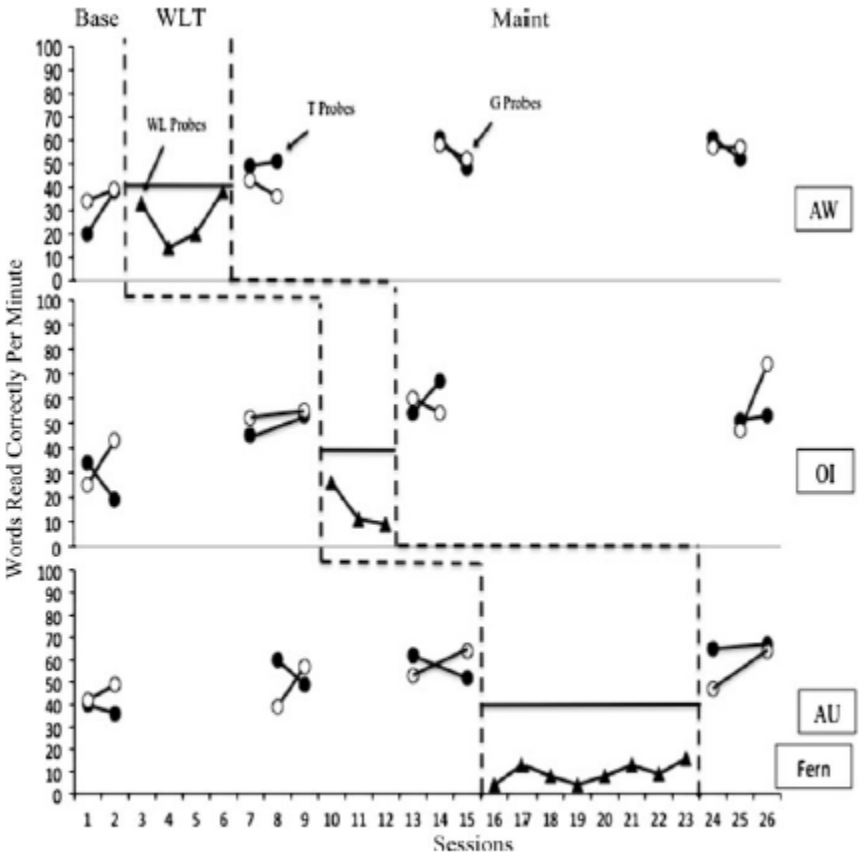

Fig. 6 Words read correctly per minute on word lists and passages across conditions for Fern (*Base* baseline, *WLT* word list training, *Maint* maintenance). The *horizontal line* indicates the WLT fluency criterion

With respect to oral reading accuracy, all three students showed generalized increases from trained to untrained words on lists (i.e., increasing trends during the WLT condition) for either two (Ian, Fern) or all three (Dante) of the target vowel combinations. Although gains were somewhat higher on target passages, all three students also showed generalized increases in their accurate reading of words containing target vowel teams in both target and generalization passages after training. In all cases, these gains were maintained above baseline levels during subsequent passage probes. In terms of oral reading fluency, all students showed generalized gains to word lists and passages after training on the *aw* vowel team, with two students showing increases prior to training on the other two vowel teams. Generalized fluency gains for the *aw* vowel team were similar for target and generalization passages and were also maintained during subsequent probes. For the other two vowel combinations, generalized gains in oral reading fluency were either **[end of page 32]**

Table 3 Mean WCPM on word lists and passages across conditions

Name	Vowel team/ passage		Base 1	WLT	Base/Maint 2	WLT	Base/Maint 3	WLT	Maint 4
Dante	AW	T	45.5		56.5		70.0		76.5
		G	45.0	16.0	51.5		63.5		68.5
	OI	T	42.5		58.5		62.5		74.5
		G	50.5		59.5	16.2	67.0		73.0
	AU	T	49.0		58.5		63.5		70.0
		G	47.0		52.0		56.0	9.0	64.5
Ian	AW	T	47.0		64.5		67.5		66.5
		G	57.5	24.2	58.5		53.0		63.0
	OI	T	51.0		54.5		63.5		62.5
		G	60.0		57.5	30.0	58.0		67.5
	AU	T	51.5		53.5		54.0		62.5
		G	67.5		58.5		56.5	15.3	58.0
Fern	AW	T	29.0		50.0		54.5		56.5
		G	36.5	26.3	39.5		55.0		57.0
	OI	T	26.5		49.0		60.5		52.0
		G	34.0		53.5	15.3	57.0		60.5
	AU	T	38.0		54.5		57.0		66.0
		G	45.5		48.0		58.5	9.4	55.5

WCPM words correct per minute, *WLT* word list training, *T* target passage, *G* generalization passage, *Base* baseline, *Maint* maintenance

not observed (Ian) or occurred prior to training presumably as a result of practicing the passages (Dante, Fern).

Although preliminary, these results suggest that training students to blend words in isolation with modeling and feedback followed by practice and reinforcement for generalizing the skill to untrained words on lists may be a promising way to promote generalized oral reading competence. In the present study, training was clearly effective at increasing students' generalized oral reading accuracy of target words in both word lists and passages. This is not surprising given that the training package involved direct instruction in how to blend words containing each of the target vowel combinations. Moreover, with the exception of the *oi* vowel team, students received between four and nine training sessions and showed increasing trends in the accuracy with which they were able to read untrained words on lists. Taken together, these results suggest that the training package promoted stimulus control over accurate responding to these word classes, enabling students to apply the skill in different contexts (i.e., target and generalization passages).

In contrast to the accuracy results, generalized increases in students' oral reading fluency were observed after training on the *aw* vowel team, with two students showing increases prior to training on the other two vowel teams. On average, students increased 10 WCPM after training on the *aw* vowel team. Ardoin and Christ (2009) reported a mean standard error of the estimate (SEE) for third-grade **[end of page 33]** AIMSweb passages of 11.89 WCPM. Previous research has suggested that the standard error of measurement (SEM) for curriculum-like probes can range from 4 to 15 WCPM depending on how probe sets are selected, with a standard deviation (SD) of 42 WCPM reported for a set of 50 third-grade passages administered to second- and third-grade students (Christ and Ardoin 2009). Although our students' gains did not exceed the SEE reported by Ardoin and Christ, we used the same four probes repeatedly for each vowel team and these probes were selected based on similar WCPM during pre-experimental screening. As such, we would expect the SEM for probes used in the present study to fall on the lower end of the 4–15 WCPM range. In fact, the SD across students on the *aw* probes at baseline was 8.4, far less than the 42 reported by Christ and Ardoin. There is good reason to believe, therefore, that generalized gains on the *aw* passage probes exceeded the SEM of these probes in the current study.

As noted earlier, *aw* was the only vowel team for which all three students met or came close to meeting the fluency criterion before training ended due to a lack of generalization words. Students were not trained to the fluency criterion on the other two vowel combinations, and as a result, we failed to obtain within-subject replications of the training effects across these two skills. This is clearly a limitation of the study. However, the finding that positive results were obtained only for the vowel team trained to criterion and that these results were replicated across participants is promising. Similar to previous RR research (e.g., Bonfiglio et al. 2004; Martens et al. 2007), this suggests that training to a fluency threshold (i.e., a functional fluency aim) may also be a way of promoting the

generalization of phoneme blending skills. Because we chose the fluency criterion in the present study somewhat arbitrarily (i.e., 50 % of students' fluency on high-frequency word lists), additional research is needed to identify lower bounds on functional fluency aims for this and other phonics skills. In the future, researchers should also devise strategies for training students to a fluency criterion without jeopardy of running out of generalization words. Such strategies might involve the use of nonsense words for training and real words for generalization assessment as in Daly et al. (2004) or training in broader word families.

Although training to the fluency criterion may have partly accounted for students' generalized oral reading fluency gains, our training package involved several components including direct instruction of sound blending with modeling and feedback, practice with a mix of known and unknown words, and a reinforcement contingency for generalized fluency of the skill to untrained words on lists. This latter component (i.e., reinforcement for generalized fluency) has been shown to promote generalization in previous research (Daly et al. 2005) and may have contributed to the effects seen for the *aw* vowel team in this study. It is also possible that different components of our training package differentially affected students' generalized oral reading accuracy (e.g., direct instruction) versus fluency (e.g., the reinforcement contingency). It might be useful in future research to conduct a component analysis of the training package in relation to different performance dimensions (i.e., accuracy vs. fluency).

Finally, the training data suggest that the *aw* vowel combination may have been easier for students to master. Specifically, students met the fluency criterion for this **[end of page 34]** vowel combination in either four or five trainings, but did not meet criterion for *au* words even after seven to nine trainings. Despite the small number of trainings we were able to provide for the *oi* vowel team, decreasing trends in fluency were evident in each case. Prior to starting the study, we screened students for their inability to pronounce the *aw*, *oi*, and *au* vowel digraphs and then targeted these for training. Perhaps, words containing the *oi* and *au* digraphs were more difficult due to the number of syllables or frequency of occurrence in grade-level readers. It would be important to control for these variables across conditions in future research. It may also be the case that more difficult or less common phonics patterns (e.g., the schwa vowel sound) simply require more training before generalization occurs. Future research should evaluate the effects of fluency training on other phonics patterns (e.g., consonant digraphs, silent e-controlled long vowel sounds) that vary in their frequency of occurrence.

Other limitations of the study should also be noted. First, the experimental passages were rewritten to contain more words with the target vowel combinations. As a result, students were presented with more opportunities to generalize the skills that were trained. Whether similar results would be obtained using more typical passages would be a direction for future research. Second, although we recruited students who were frustrational for their grade based on school-wide DIBELS screening (i.e., 28–30 WCPM at screening), both Dante and Ian read more WCPM on the AIMSweb passages that were used to assess for generalization (40 and 52 WCPM, respectively). Previous research has shown greater generalization when students are assessed on easier or instructionally matched passages, and this may have been a factor in this study. Third, the amount of prior phonics instruction the students received was unknown. It seems likely that phonemic awareness would be prerequisite to students benefitting from the training package used in this study. Additional research is needed to determine whether similar results would be obtained with younger or less skilled readers or when assessed with more difficult reading material.

Despite the study's limitations, the results suggest that fluency training in phoneme blending may be promising as an intervention for promoting generalized oral reading accuracy and fluency. Our results are consistent with the National Reading Panel's (2000) assertion that the fluent application of phonics skills is critical to reading, and the training package we evaluated may be applicable across a range of phonics skills.

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