PROMOTING AWARENESS OF SOUNDS IN SPEECH (PASS): THE EFFECTS OF INTERVENTION AND STIMULUS CHARACTERISTICS ON THE BLENDING PERFORMANCE OF PRESCHOOL CHILDREN WITH COMMUNICATION IMPAIRMENTS

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Abstract. The primary purpose of this study was to demonstrate the efficacy of the blending portion of the Promoting Awareness of Sounds in Speech (PASS) program, a comprehensive and explicit phonological awareness intervention curriculum designed for preschool children with speech and language impairments. A secondary purpose was to examine the effects of stimulus characteristics on responsiveness to the phonological awareness intervention via post-hoc analysis. A single-subject design was used to examine treatment effects among children with varying levels of communicative abilities. The PASS blending module was implemented with 11 children with speech and/or language impairments, following the establishment of a stable pretreatment baseline on a series of phonological awareness probes.

After instruction, the children demonstrated substantial improvement in their blending ability, which appeared to be attributable to the intervention rather than environmental or maturational factors. These findings suggest that PASS blending training was an effective approach to phonological awareness instruction for the preschoolers with disabilities in our sample. Additionally, word frequency and neighborhood density were found to influence performance on some phonological awareness tasks. Specifically, children correctly blended high-frequency words more than low-frequency words, but they correctly blended words from lower-density neighborhoods more than words from higher-density neighborhoods. Findings are discussed with respect to predictions of the lexical restructuring hypothesis.

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Preschool children with identified speech and language deficits are at substantial risk for developing literacy problems in elementary school that may persist into adolescence (Bishop & Adams, 1990; Catts, 1993; Scarborough, 1990; Tallal, Curtiss, & Kaplan, 1988). In fact, these children comprise the largest segment of youngsters who are later identified with learning disabilities (LD; U.S. Department of Education, 1997).

Several variables influence the future literacy accomplishments of at-risk children, including socioeconomic status, family literacy practices, instruction, and cognitive and linguistic abilities (Hart & Risley, 1995; National Reading Panel, 2000). Phonological awareness, and particularly phonemic awareness – the knowledge that spoken words are composed of individual sounds and the ability to manipulate those sounds – is well documented as a connection between linguistic abilities and early literacy achievement. Thus, phonemic awareness has been shown to be an essential component of beginning reading and writing acquisition for children with and without disabilities (e.g., Perfetti, Beck, Bell, & Hughes, 1987; Roth, Speece, & Cooper, 2002; Torgesen, Wagner, & Rashotte, 1994).

Young children with speech and language deficits are often delayed in acquiring phonological awareness (Larrivee & Catts, 1999; Webster & Plante, 1992, 1995). For example, Catts (1993) and Magnusson and Naucler (1993) found that preschool children with language impairments scored significantly lower on measures of rhyming than their typically developing peers. Clinical intuition suggests that preschoolers with global communication impairments present with more severe literacy problems in the primary school years than children with isolated impairments. Longitudinal data reported by Lewis, Freebairn, and Taylor (2000) confirmed this hypothesis. The 4- to 6-year-old children with combined speech and language disorders in their study performed significantly lower than children with speech deficits only on measures of phonemic awareness, word reading, reading comprehension, and spelling in 3rd and 4th grade.

A multifaceted and strategic instructional approach is likely to be most beneficial for at-risk children because no single area of focus will alter the ultimate disposition of children prone to language-related literacy deficits. Research shows that one critical pedagogical focus within a comprehensive early literacy program is explicit instruction in phonological awareness, yielding gains in phonological awareness, word recognition, and spelling skills for typically developing as well as children with disabilities (e.g., Byrne & Fielding-Barnsley, 1991, 1993, 1995; Gillion, 2000, 2002; Hesketh, Adams, Nightingale, & Hall, 2000; Major & Bernhardt, 1998; Torgesen, Morgan, & Davis, 1992).

Most phonological awareness intervention studies have been conducted with children in the elementary school grades. Few efforts have been directed at the preschool population, and even fewer at very young children with disabilities (cf. Pullen & Justice, 2003; Troia, 1999; van Kleeck, Gillam, & McFadden, 1998). Yet, the existing evidence for positive impacts is promising. In a study conducted by van Kleeck et al. (1998), children with speech and/or language disorders between 4 and 8 years of age made reliably significant progress on phonemic awareness tasks (e.g., judging initial sound sameness, identifying initial and final phonemes) after 24 weeks of in-class training by researchers. Similar results were reported by Pullen and Justice (2003) for at-risk preschoolers.

Successful language and literacy outcomes for young children with communication impairments are likely maximized by early intervention. That is, the more children know about literacy-related language before they enter school, the more likely they are to successfully learn to read and write (Snow, Burns, & Griffin, 1998). Early intervention that focuses on the sound structure of spoken language may prevent, or at least lessen, the likelihood of academic failure (Fey, Catts, & Larrivee, 1995; Fletcher et al., 1994; Gough & Tunmer, 1986). According to Foorman, Francis, Fletcher, Schatschneider, and Mehta (1998), kindergarteners who show little or no growth in phonological awareness during their first year of school typically become the poorest readers for the remainder of elementary school. It is possible that the same outcome might befall preschoolers with delayed phonological awareness. A comprehensive intervention program that can help preschoolers acquire greater phonological awareness before the introduction of formal literacy instruction may help tilt the scales in their favor.

The intervention program reported here, Promoting Awareness of Sounds in Speech (PASS; Roth, Troia, Worthington, & Dow, 2002), was developed to build upon existing approaches to phonological awareness instruction by providing a comprehensive curriculum designed specifically for preschool children with speech and language impairments. It contains detailed lessons and specific learning objectives ordered in a developmentally appropriate sequence. PASS consists of three independent training modules that were created to promote rhyming, sound blending, and sound segmentation capabilities in young children. Each module is implemented in conjunction with systematic training in the alphabetic principle.

Our initial study (Roth et al., 2002) demonstrated the efficacy of the rhyming training module using a single-subject, multiple-baseline-probe-across-behaviors research design with 8 preschool children with speech and/or language impairments. All children showed dramatic improvement in their ability to produce rhymes (the most difficult training objective). Prior to training, no child achieved greater than 54% mean accuracy; following training, no child achieved less than 76% mean accuracy. Additionally, in 6 of 8 cases, rhyming production performance improved from an average of less than 10% accuracy to an average of at least 80% accuracy. These findings demonstrate that preschool children with speech and language impairments can benefit from direct, explicit instruction in phonological awareness earlier than is typically thought of as therapeutically appropriate.

The present study reports the results from the blending module, which, from a developmental perspective, is the next logical phonological awareness skill to train because, compared with rhyming, blending places greater demands on cognitive processing (e.g., memory) and requires a greater degree of linguistic analysis. Yet, it is not as difficult as segmentation (Adams, 1990; Troia, Roth, & Graham, 1998; van Kleeck & Schuele, 1987).

We also explored the influence of certain stimulus characteristics on phonological awareness learning through post-hoc analysis. Our selection of characteristics to study was informed by factors that affect word learning in young typically developing children. In particular, we examined the influence of lexical neighborhood density (ND; Logan, 1992; Luce, 1986). ND is derived by determining the number of words that differ from a target word by the substitution, addition, or deletion of any single phoneme in the target word. The word “cot,” for example, resides in a dense lexical neighborhood because it has 49 neighbors (e.g., “pot,” “cat,” “cop,” “hop”), whereas the word “crib” resides in a relatively sparse neighborhood because it only has 15 neighbors.

According to the lexical restructuring hypothesis, which asserts that expressive vocabulary growth is governed by ND (Metsala & Walley, 1998), high-density words are learned earlier than low-density words. Moreover, as words are added to the lexicon, a child’s phonological representations of individual words shift from holistic (e.g., cowboy) to segmental (e.g., cow-boy) because it becomes more efficient to store words in terms of their constituent parts rather than as wholes. Words from dense lexical neighborhoods are thought to be segmented earlier in development than words from sparse neighborhoods because they require more fine-grained segmental representations for efficient recognition and retrieval given the sheer number of similar-sounding words. As phonological representations become increasingly segmental in nature, explicit awareness of phonemes is believed to improve.

Research generally supports this hypothesis. For example, Dollaghan (1994) found that 80% of the words produced by children between 1 and 3 years of age have at least one phonological neighbor, and 20% have more than six neighbors. Similarly, Storkel (2001) showed that words with common sound sequences are learned more quickly than words with uncommon sound sequences. However, the effects of density may be mediated by the target word’s frequency in relation to the frequency of its neighbors. For example, Newman and German (2002) determined that a word such as “ban” occurs less frequently than some of its neighbors, such as “ran” and “can,” and is thus more susceptible to recognition or retrieval error. On the other hand, when examining the contribution of ND, word frequency, and word length to predicting the age at which target vocabulary is acquired by young children, Storkel (2004) found that ND was the only significant predictor. Thus, the precise contributions of density and word frequency on vocabulary acquisition in young children remain unknown.

In addition to its influence on word learning, lexical restructuring may account for the acquisition of phonological awareness skills (Metsala, 1999; Metsala & Walley, 1998). It is hypothesized that young children’s performance on phonological awareness tasks is more accurate for familiar words that reside in dense lexical neighborhoods than those in sparse neighborhoods. Available data support this prediction for both rhyming and sound blending among typically developing preschool children (DeCara & Goswami, 1999; Metsala, 1999). For example, Storkel (2002) examined the effects of word density on phonological knowledge and awareness using a forced-choice classification task in which preschool children had to choose whether two words sounded alike. Results showed that words in dense lexical neighborhoods were judged to be similar based on onset (e.g., *b* in the word “bat”) and rime (*-at* in the word “bat”). However, words from sparse neighborhoods were classified as similar, based on the phonemic similarity of the onset but not the rime.

Storkel concluded that children make more segmental distinctions in words from dense neighborhoods than from sparse neighborhoods, possibly because words residing in dense lexical neighborhoods have to be distinguished from other similar-sounding words. Results of studies with students with LD suggest that ND influences performance on word retrieval tasks as well. Thus, Newman and German (2002) and German and Newman (2004) reported that LD students between 8 and 12 years of age demonstrated fewer production errors on high-frequency words from high-density neighborhoods than high-frequency words from low-density neighborhoods.

Taken together, these results have potentially compelling implications for the selection and programming of training stimuli used in phonological interventions. That is, training items from dense lexical neighborhoods may stimulate children to make more implicit comparisons between similar-sounding words than items from sparse neighborhoods. Adjustments in stimulus density may, therefore, serve as an instructional adaptation that can place children at a considerable advantage for attaining phonological awareness and thus facilitate their early reading and writing. Of course, it also is possible that young children with speech and/or language impairments may organize their lexicons differently and less efficiently than typically developing children, and therefore not show the same effects of ND and word frequency. To explore this issue, we undertook post-hoc analyses of the relative contributions of word frequency and ND on sound

Table 1
Assessment Battery Results for Each Participant

	Child[1]										
	Sandy	**Zeke**	**Arnie**	**Tyrone**	**Brett**	**Alvin**	**John**	**Les**	**Jacob**	**Tara**	**David**
Age (in months)	51	58	63	59	54	49	56	54	53	65	60
K-BIT[a]	81	—	—	34	70	—	—	21	73	91	75
GFTA-2	12	25	18	63	16	34	10	42	22	07	79
EVT	79	32	53	13	53	39	45	23	55	77	61
PPVT-III	68	77	<1	10	77	50	32	63	42	70	10
CELF-P/LC	50	16	<1	16	37	09	45	37	63	09	01
TERA-2	96	84	52	01	04	69	21	77	27	77	71
TAPS/NF	16	91	25	16	25	01	37	37	09	16	16
WJ-R COG/SB	01	82	<1	<1	53	59	—	23	34	59	27
TOLD-P: 3/PA	16	75	01	05	16	05	84	02	09	75	25
Rhyming[b]	07	07	07	09	10	10	08	10	09	08	09
Classification[c]	S	SL	SL	L	SL*	L	S	L*	S	SL	L

[1]Pseudonyms are used in all cases.

[a]Percentile ranks are reported for norm-referenced tests; K-BIT (Kaufman Brief Intelligence Test; Kaufman & Kaufman, 1990); GFTA-2 (Goldman-Fristoe Test of Articulation-2; Goldman & Fristoe, 2000); EVT (Expressive Vocabulary Test; Williams, 1997); PPVT-III (Peabody Picture Vocabulary Test-III; Dunn & Dunn, 1997); CELF-P/LC (Linguistic Concepts subtest of the Clinical Evaluation of Language Fundamentals-Preschool; Wiig, Secord, & Semel, 1992); TERA-2 (Test of Early Reading Ability-2; Reid, Hresko, & Hammill, 1989); TAPS/NF (Auditory Number Memory Forward subtest of the Test of Auditory-Perceptual Skills; Gardner, 1985); WJ-R COG/SB (Sound Blending subtest of the Woodcock-Johnson-Revised Tests of Cognitive Ability; Woodcock & Johnson, 1989); TOLD-P: 3/PA (Phonemic Analysis subtest of the Test of Language Development-Primary: 3; Newcomer & Hammill, 1997).

[b]The number correct out of 10 items is reported for the rhyme production task adapted from O'Connor, Jenkins, and Slocum (1995).

[c]Based on the assessment battery results, children were classified as speech delayed (S), language impaired (L), or both (SL).

*Brett and Les had scores at or below the 16th percentile on other subtests of the CELF-P not reported here, and thus were identified with language disorder.

blending learning (and performance on rhyming, blending, and segmenting pre- and post-treatment probes) in our sample of preschoolers with communication disorders.

METHOD

Participants

The participants were 11 children, 2 females and 9 males, between the ages of 4 and 6 years old ($M = 4.71$, $SD = .41$), who were identified with language impairments and/or expressive phonological delay. All children were native English speakers from middle-class homes. Seven of the children were Anglo-American; four were African-American. None of the participants had concomitant cognitive, sensory, physical, or emotional/behavioral disabilities based upon entrance criteria for the preschool program in which they were enrolled. Additionally, all of the participants for whom we had data obtained IQ scores ranging from low average to above average (see Table 1).

Each participant attended the same university preschool program for children with communication disorders. Children in the program participate in three half days of classroom instruction and three 30-minute individual treatment sessions per week. Between 8-10 children attend the class, in which effective communication skills are facilitated through structured developmental and theme-based play, literature-based activities, computer games, and basic concept instruction.

In addition, the classroom curriculum incorporates the Orton-Gillingham-Stillman (Gillingham & Stillman, 1992) multisensory approach for teaching the alphabetic principle. In this approach, a variety of activities, including music, drama, crafts, and play, serve as mechanisms for establishing each grapheme-phoneme association. Throughout instruction, haptic (i.e., touch) and phonotactic (i.e., articulatory-motor) cues are emphasized. Classroom instruction in the alphabetic principle took place at least twice a week and typically lasted 15-20 minutes. In general, a letter-of-the-week approach was used, meaning that at least two lessons (but not more than four) were devoted to each symbol-sound correspondence introduced. Some letters (e.g., "l," "q," "r") were not introduced because their associated sounds were deemed too difficult for the children to pronounce or they occurred infrequently in print.

Potential candidates for the study were nominated by the director of the program based on (a) the children's performance on a battery of norm-referenced oral language tests routinely administered upon entrance into the program; (b) observations of the children's expressive language capabilities; and (c) the children's perceived readiness for instruction in phonological awareness. Study participants had to be able to participate meaningfully in a conversation (i.e., make relevant contributions over several conversational turns) and had to demonstrate a sufficiently diverse phonemic repertoire (i.e., correct or approximated production of at least 50% of English consonant sounds).

These candidates were administered a battery of norm-referenced and performance assessment tasks during two 90-minute sessions to evaluate their speech and language development, early literacy achievement, and phonological processing skills (see Table 1 for these data). Only children who performed at or below the 16th percentile on at least one of the norm-referenced measures were included in the study. Of the 11 participants, 3 were classified as speech delayed, 4 as language delayed, and the remaining 4 children were identified as speech and language impaired.

Experimental Design and General Procedures

We selected a multiple-baseline design across behaviors (i.e., rhyming, sound segmentation, and sound blending) to investigate the effectiveness of the PASS intervention program. Minor modifications to the PASS program were executed in the first year of the study as soon as there was evidence that specific training items, activities, instructions, or feedback statements were inadequate or inappropriate for teaching the targeted phonological awareness behavior (i.e., blending) to the preschoolers. As an example of this, a simple pointing response replaced a gross-motor response in one of the game activities. These small changes did not substantively alter the blending treatment participants received.

The research protocol comprised three phases.

Phase 1. In the first phase, a series of probes for the three phonological awareness skill areas were individually administered to each participant to establish a stable preinstructional baseline of performance. Separate rhyming, sound segmentation, and sound blending probe tasks (described later) were administered during a single 30-minute probe session and were repeated at least twice to obtain a stable baseline. The order of probe administration (rhyming, segmentation, blending) was held constant across probe sessions and participants. Stability was deemed evident if the level (i.e., magnitude) of the plotted data points for blending fell within a 15% range of the mean level of the data series and if the trend of the data series was characterized by a zero celeration or decelerating slope (see Tawney & Gast, 1984). The pretreatment probes were administered by either graduate student clinicians or advanced-level undergraduate students from the preschool program who would serve as instructors during the intervention phase of the study (no effort was made to randomize the assignment of probe administrators and instructors to participants).

Phase 2. The second phase of the study involved implementation of the intervention program. Participants were individually trained in blending three days per week over a period of 6-8 weeks. The students were taught by different instructors, who used scripted lesson plans. Each lesson lasted 30 minutes and supplemented the children's classroom instruction and individualized speech and language treatment. Instruction was criterion- rather than time-based; that is, the participants were required to attain a performance level of 80% accuracy for each instructional objective (there were only two objectives for the blending module) over two lessons before advancing to the next objective or exiting the program. This mastery criterion was selected because it is widely used in intervention programs based on a direct instruction model (Polloway, Patton, & Serna, 2001). A single probe for each phonological awareness skill area was administered after a child achieved mastery of the first objective but prior to instruction for the second objective. This provided a better estimate of each child's growth in phonological awareness.

Phonological awareness instruction (other than that which occurred incidentally through letter-sound association training) was prohibited during classroom activities and individualized therapy. The preschool director, who also is the last author, met weekly with the other researchers to debrief them about the classroom activities and therapeutic sessions each participant had experienced during that week. In this way, fidelity of treatment was monitored, and adherence to the requirement that no ancillary phonological awareness instruction occur was confirmed.

The area of phonological awareness in which a student would first receive instruction was decided based upon pretreatment probe data. Specifically, if a child's average score for the series of baseline rhyming, sound blending, or sound segmentation probes was equal to or greater than 80% accuracy, he or she was credited for achieving mastery of that skill area and another skill was selected for intervention. The children had already participated in the rhyming module of the PASS program. All met or exceeded criterion for rhyming (the most fundamental of the three skill areas). Additionally, all the children performed at or below 10% accuracy on the baseline blending probes; consequently, blending was the area of phonological awareness for which these children received intervention.

Phase 3. In the last phase, once all lessons for the trained skill area were completed, the probe tasks for rhyming, segmentation, and blending were readministered during a series of three post-treatment probe sessions. Functional independence of the three phonological awareness target behaviors and, thus, experimental control and treatment efficacy were demonstrated if (a) the level and trend of posttreatment probe data were substantially superior to baseline performance; (b) the areas for which training did not occur showed little or no improvement; and (c) the effects of intervention were replicated across phonological awareness behaviors. (Because we are reporting the results from only one module of the PASS program, the last condition for experimental control and treatment efficacy cannot be established.)

The research study was conducted over four years. Due to the nature of the university preschool program, no child was able to complete the entire PASS intervention program (children usually attended the preschool for only two semesters and, in some instances, a summer). Consequently, implementation of training was staggered for groups of students. One group of participants began blending training in the spring semester of 2000, another in the spring of 2001, a third in the spring of 2003, and the last in the spring of 2004. Two children formed the first and second cohorts, four the third cohort, and three the fourth cohort.

Probes

A probe task was developed for each phonological awareness target behavior – rhyming, sound segmentation, and sound blending. Each probe consisted of one demonstration item, one practice trial item, and 10 test items. The probe stimuli (see Appendix) were one- or two-syllable real words, selected for their potential familiarity to preschool children with developmental disabilities, based on expert judgment. The stimuli for each probe were, to the extent possible, balanced for consonant and vowel diversity. None of the probe items was used for explicit training activities during the intervention phase to permit an evaluation of stimulus generalization. Response errors that were clearly the result of a child's phonological impairment were judged correct (e.g., a child who exhibited a fronting error pattern and who responded with /taɪt/ when asked to blend /k/-/aɪ/-/t/ received credit for the response). All probe results were scored by the examiner and another trained individual to establish interscorer reliability. Percent agreement ranged from 93% to 100%.

Given our interest in determining how stimulus characteristics might play a role in phonological awareness performance and responsiveness to intervention, we determined the frequency and ND for each stimulus item on each probe after the completion of the intervention study. Stimulus frequency was based on the U-values (relative frequency per million) for written

Table 2
Descriptive Statistics for Probe and Instructional Stimuli Frequency and Density

	Density			Frequency			
Stimuli	**Mean**	***SD***	**Median**	**Mean**	***SD***	**Median**	***r***
Rhyming Probe	9.10	6.49	9.50	191.65	302.66	52.73	.66*
Blending Probe	16.00	5.18	16.00	53.43	73.52	12.76	.13
Segmenting Probe	14.80	5.50	17.00	249.87	483.48	40.05	-.03
All Probes	13.30	6.49	15.00	164.51	341.37	21.87	.15
Blend Recognition	15.30	4.69	15.50	62.34	83.71	33.91	-.36*
Blend Production	15.00	6.36	15.00	108.70	179.26	18.98	-.55*
All Lessons	15.09	5.91	15.00	94.79	158.23	24.16	-.52*

* $p < .05$.

words reported in the Carroll, Davies, and Richman (1971) corpus. ND was based on the work of Luce and Pisoni (1998), and was derived by comparing the phonetic transcription of the stimulus word with phonetic transcriptions of all possible neighboring words (i.e., words that share at least one phoneme in common with the stimulus) and tallying the number of such neighbors. We then calculated descriptive statistics for the set of stimuli on each probe task as well as the correlation between stimulus frequency and density; these data are shown in Table 2.

Rhyming. The child was asked to provide a word that rhymed with the stimulus spoken by the examiner. Feedback regarding the accuracy of the responses to the demonstration and practice trial items was provided. If the child did not provide a correct response for a demonstration item, a correct response was modeled. No feedback was provided for test item responses. Self-corrections were permitted.

A response was scored as correct if it was a real or nonsense word that differed from the stimulus only with respect to the onset portion of the word. The number of correct responses was used to calculate percent accuracy.

Sound segmentation. The child was instructed to state, in order, each sound present in the stimulus word. Because of the working memory demands of this task, a picture accompanied each item and three blocks were used to represent the phonemes in each word. The child was asked to look at the drawing as the examiner pronounced the stimulus. Below the picture were three squares in which the child placed the blocks, one at a time, as he or she said the first, middle, and last sound of the word. The examiner guided the child by pointing to each square and asking what sound belonged to it. Again, feedback and modeling were provided before the test items were administered. Self-corrections were permitted, but the examiner never prompted the child to return to a previous square. If, for example, the child said “sun” while placing a block in the first square and then said /s/ while placing a block in the second square, the examiner had the child proceed to the third square.

A response for an item was scored as correct if each phoneme in the stimulus word was segmented in its proper sequence. The number of correct responses was used to calculate percent accuracy. Additionally, the number of individual phonemes preserved while responding to each stimulus item was recorded (e.g., if the child said “s-un-n,” the phonemes preserved score was 2).

Sound blending. The child was asked to blend individual phonemes, pronounced by the examiner at one-second intervals, to form a whole word. As with the other phonological awareness probes, feedback and modeling were provided before the test items were administered and self-corrections were permitted. Percent accuracy and the number of phonemes preserved per item were calculated.

Materials

The materials for the intervention program were developed by the researchers or derived from commercial resources. We included numerous exposure activities that incorporated children's literature, songs and nursery rhymes, games, crafts, and movement. For matching (i.e., recognition of a segmented word) lessons, explicit training stimuli were accompanied by pictures culled from several sources.

The stimuli for explicit training in blending were one-syllable consonant-vowel-consonant (CVC) words, selected for potential familiarity and balanced for phonemic diversity. Twenty stimuli were included in each lesson. Just as for the probe stimuli, we determined the frequency and density of each training stimulus item post hoc and calculated descriptive statistics for the stimuli used for each lesson as well as the correlation between stimulus frequency and density; these data are presented in Table 2.

In an effort to support learning transfer, training stimuli, once used to teach a particular objective in a phonological awareness skill area (i.e., blending), were not used again during the course of intervention for the same area. For matching lessons, the first half of the stimuli were segmented CV-C whereas the second half of the stimuli were segmented C-VC.

Fidelity of Treatment

The following safeguards were implemented to ensure that treatment procedures were conducted as planned. First, all the graduate and undergraduate student instructors received extensive training for implementing all three phases of the research protocol. Second, lesson plan checklists were developed for the instructors to document the completion of each step of a lesson. Third, at least two lessons were observed each week by the investigators, and weekly debriefings were held with the instructors to discuss problems and concerns and to brainstorm potential solutions. Fourth, all training sessions were tape recorded, and one fourth of the audiotapes were randomly selected at the end of the study for scoring by an examiner unfamiliar with the purpose and design of the study. The examiner listened to an audiotape and checked off each step on the corresponding lesson plan as it was completed.

A range of 80-100% of the instructional steps for each lesson was completed. In all but two cases, the intervention steps were faithfully implemented with at least 90% accuracy.

Instructional Procedures

Two instructional objectives were addressed in the blending intervention: matching (i.e., selecting the picture that represented a spoken segmented CV-C or C-VC word from two picture choices) and production (i.e., blending a spoken segmented C-V-C word). Each lesson for each objective followed the same format – explicit training was preceded by one or two exposure activities, followed by a repetition or continuation of the same activities. If a child failed to meet the training criterion of 80% accuracy for an objective over two lessons, an alternate lesson was presented. While using the same training stimuli as the basic lessons, this lesson consisted of different exposure activities. When necessary, the alternate lesson was employed twice. In this way, a variety of warm-up and cool-down activities helped to promote continued interest and participation while the use of the same training items maximized the benefits of repetitive practice.

Two preskill development lessons were provided to each child for each objective. Each of these lessons employed auditory bombardment activities (e.g., joint book reading in which target words were orally segmented and then blended for the child). The purpose was to provide exposure to the concept of blending in an enjoyable, nonthreatening context before explicit instruction was begun.

Several strategies were used to facilitate the children's progress through the program. First, participants were required to name all the pictured stimuli in a lesson before instruction commenced. If a child was not able to give the name of a picture, the instructor provided it. Second, the instructors clearly explained and modeled the task demands and target behaviors. Third, feedback and, if necessary, error corrections were supplied for every response during explicit skill training. Lastly, participants were rewarded for their attention and compliance during explicit training exercises on a fixed-interval schedule of reinforcement. Specifically, after every fourth response, they were permitted a turn at an age-appropriate game.

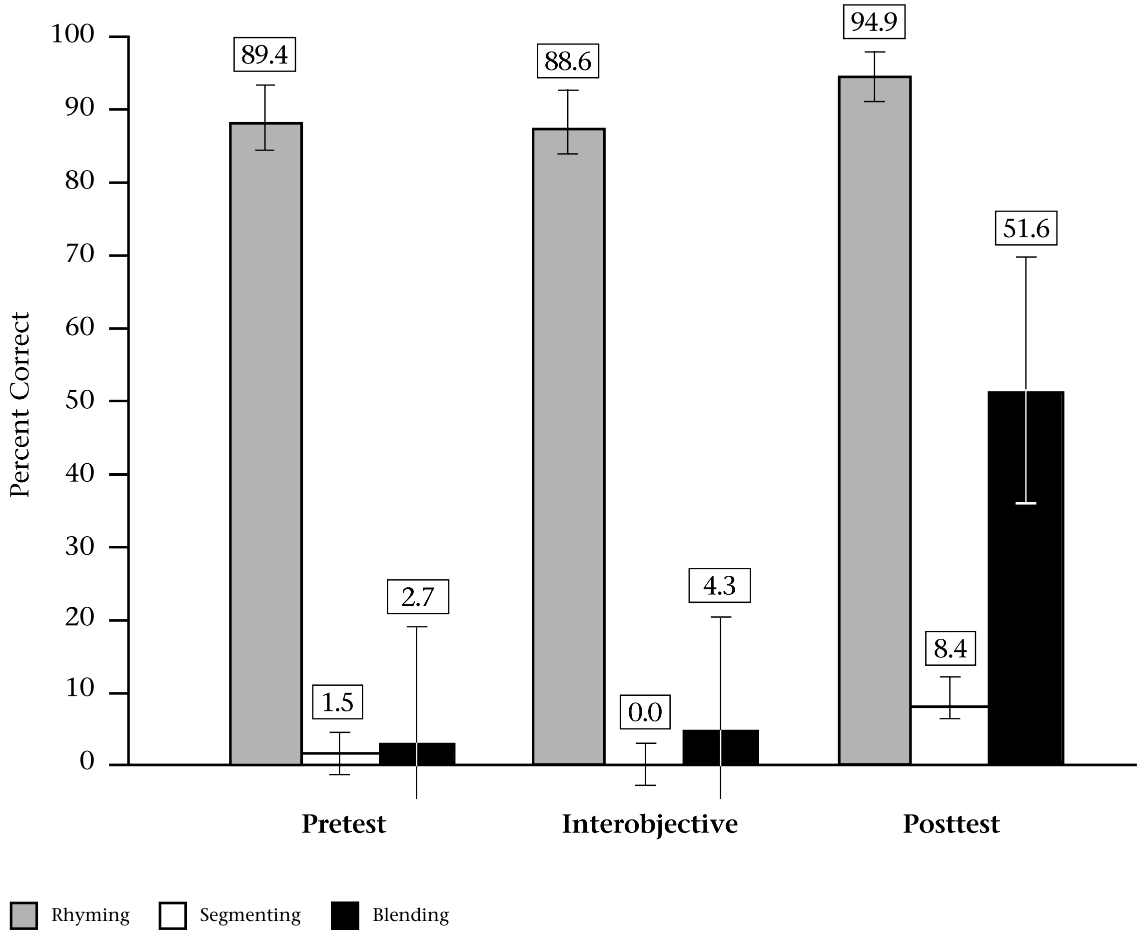
RESULTS

Treatment Effects

Paired samples *t*-tests were used to examine the effects of the blending intervention and participants' growth in phonological awareness. Average pretest, interobjective, and posttest probe accuracy scores were calculated for each phonological awareness skill area (averaging across participants and multiple probe series, when applicable); these data are shown in Figure 1.

For blending, the average gain of nearly 49% correct from pretest to posttest was statistically significant and represented a large treatment effect ($t = -5.47$, $df = 10$, $p < .05$, $ES = 2.87$). The average gain of about 6% correct in rhyming performance also was statistically significant, representing a moderate treatment effect ($t = -2.60$, $df = 10$, $p < .05$, $ES = 0.67$). However, the average gain of approximately 7% correct in segmenting performance

Figure 1. Average phonological awareness probe accuracy.



was not statistically significant (t = -1.20, df = 10, $p > .05$).

For the blending and segmenting probes, we derived the average percentage of stimulus items (once again, averaging across participants and multiple probe series, when applicable) for which zero, one, two, or three phonemes were preserved; these data are displayed in Figures 2 and 3, respectively. From pretest to posttest, there was a decrease of about 58% in the proportion of blending items for which none of the phonemes present in the stimulus was preserved, and a corresponding increase of nearly 46% in the proportion of blending items for which all three phonemes were preserved. However, these shifts were observed only following training in blending production (the second treatment objective). In contrast, the proportion of segmenting items for which none of the phonemes was preserved decreased only by approximately 14%, and was accompanied by a corresponding increase of just about 8% in the proportion of segmenting items for which all three phonemes were preserved. Once again, these shifts occurred only after the participants were taught how to blend phonemes into words.

Figure 4 shows the participants' average percent correct for each blending training objective and for series of lessons for each objective. As a group, the

Figure 2. Average percent of blending probe items by number of phonemes preserved.

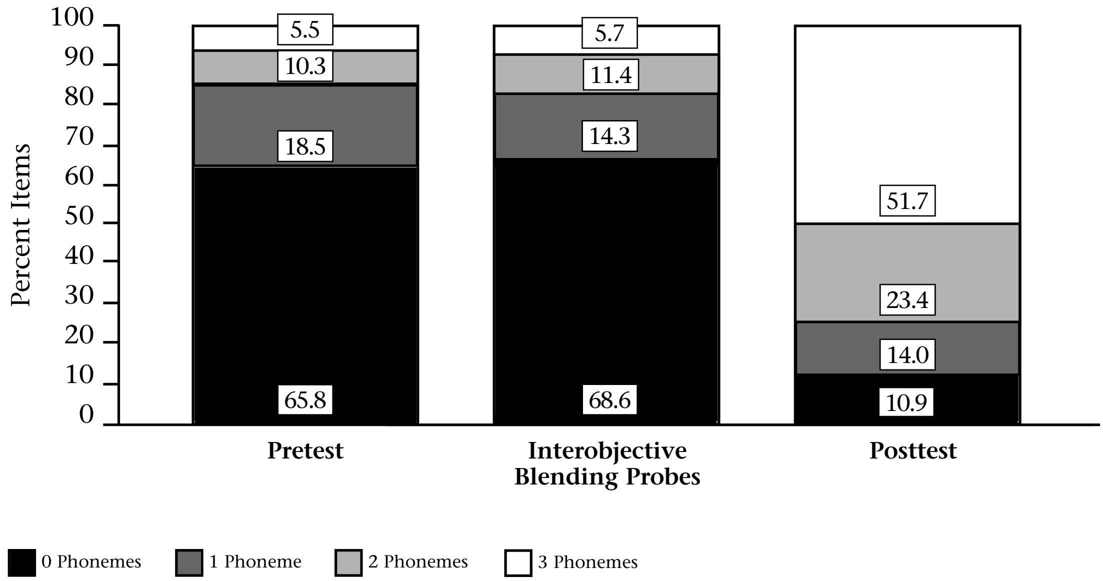
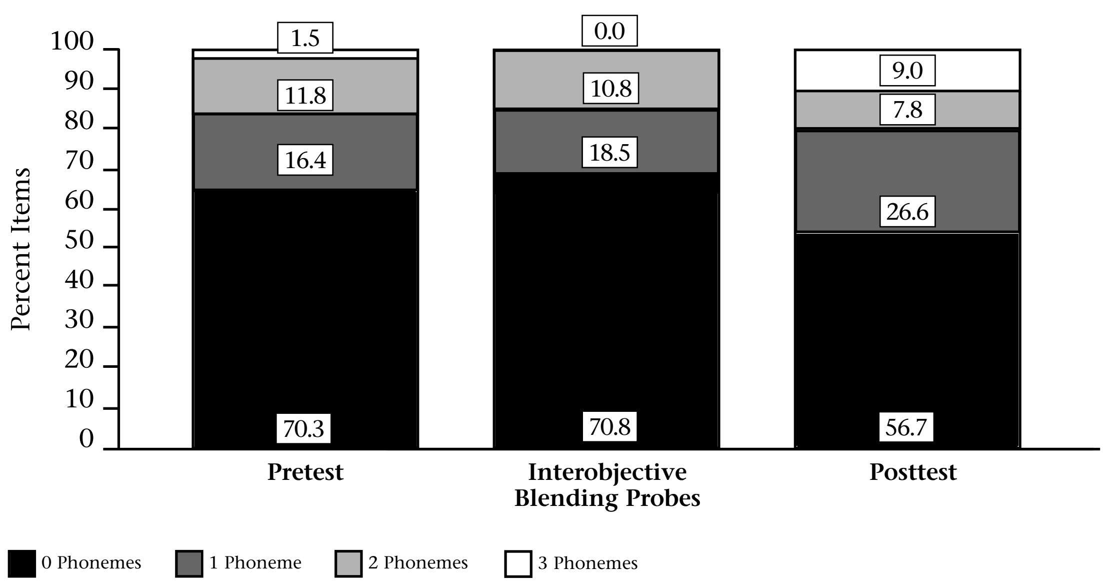


Figure 3. Average percent of segmenting probe items by number of phonemes preserved.



preschoolers demonstrated immediate mastery of blending recognition (i.e., matching a picture to a word spoken in segments), exceeding the training criterion of 80% accuracy over two lessons. No child required more than two recognition training sessions (4 participants only received one lesson in blending recognition and achieved between 95-100% accuracy; see below). Blending production (i.e., pronouncing a word in response to a segmented stimulus) clearly was a more challenging task; only 6 (out of 9; 2 children did not receive any blending production training due to time constraints) of the children met or exceeded the training criterion (see below).

Across eight lessons, the 9 preschoolers' average blending production accuracy was only 58%. However, there was an interaction between task performance and amount of training. When we examined average blending production performance for each lesson, we observed a substantial increase between Lessons 3 (32.1%) and 4 (50.0%) and again between Lessons 4 and 5 (67.5%). Moreover, little change was observed in the first three lessons (range of 25.7-38.3% correct), but steady progress was evident in the last five lessons (range of 50.0-90.0% correct). Consequently, we selected Lesson 4 as a breakpoint, and collapsed Lessons 1-4 and 4-8. As seen in Figure 4, there was a 37% jump in performance between these blending production lesson series. After two hours of blending production intervention (four sessions), children achieved less than 40% accuracy; with double that time, they achieved nearly 75% accuracy.

Results for participants in the first, second, third, and fourth cohorts are presented in Figures 5, 6, 7, and 8, respectively. In each figure, baseline, interobjective, and posttreatment probe scores across the three phonological awareness behaviors are shown for each participant in the cohort, as well as treatment session data. The treatment session data are not joined across the two blending objectives because performance levels during training would not be expected to remain stable while a child progressed from the easier to more challenging task and because the interobjective probe was administered between objectives. Only children in the third and fourth cohorts were administered interobjective probes when this feature of the design was added in 2003.

Spring 2000 cohort. The two preschoolers from the first cohort, John and Arnie (pseudonyms are used in all cases), both demonstrated limited growth in their blending skills; however, neither received training in blending production, and both participated in only a single blending recognition lesson in which they achieved 100% accuracy (see Figure 5). John's performance rose from a baseline average of 3.3% correct on the blending production probe to a posttreatment average of 26.7%. Arnie's performance rose from an average of 0% accuracy in blending production at pretest to an average of 13.3% accuracy at posttest.

Both children had participated in the PASS rhyming training module, which concluded during the same spring semester and explains why they received so little blending instruction. As expected, their performance on the baseline and posttreatment rhyming production probes was at mastery levels: John's baseline average was 86.7% and his posttest average was 100% whereas Arnie's baseline average was 100% and his posttest average was 86.7%. In contrast, neither child was able to segment phonemes (both obtained scores of 0% accuracy on each baseline probe) prior to blending instruction, and their performance remained unchanged following treatment.

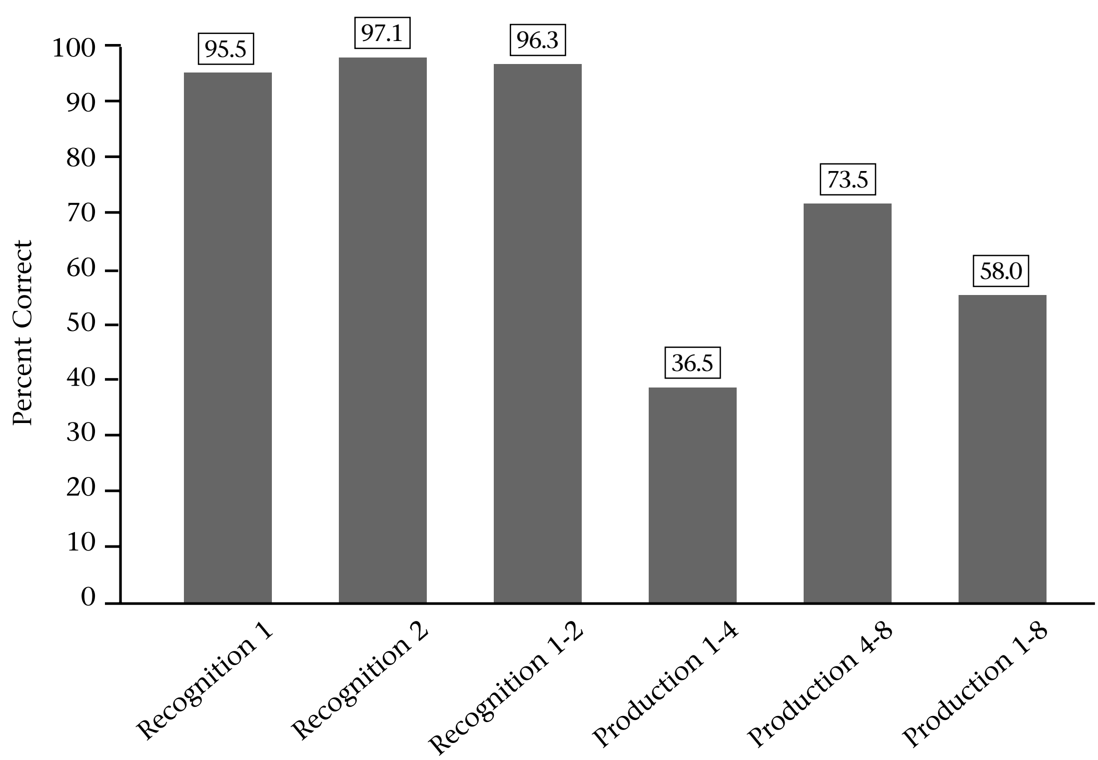
Spring 2001 cohort. Alvin and Zeke participated in a single blending recognition training lesson and a single blending production training lesson, achieving between 95-100% correct for each objective (see Figure 6). Both children exhibited dramatic improvements in their ability to blend sounds into words following intervention: Alvin increased from a baseline average of 0% correct to 96.7% correct and Zeke from 3.3% correct to 90% correct. The posttreatment performance levels achieved by these two participants closely matched their performances on the terminal objective of blending production during training.

Both Alvin and Zeke had participated in the PASS rhyming training module earlier in the spring semester; consequently, they demonstrated mastery of rhyming production on the pre- and posttreatment probes. Alvin's baseline and posttreatment averages were both 93.3% whereas Zeke's baseline average was 80% and his posttreatment average was 100%. Although Alvin displayed no ability to segment phonemes prior to or following blending instruction, Zeke made substantial progress in this skill area. Thus, his baseline average for the segmentation production probes was 16.7% and his posttreatment average was 80%. One possible explanation for Zeke's remarkable improvement in the absence of explicit segmentation instruction is that, unlike any other children in our sample, his scores on the TERA-2, the Auditory Number Memory Forward subtest of the TAPS, the Sound Blending subtest of the WJ-R Tests of Cognitive Ability, and the Phonemic Analysis subtest of the TOLD-P: 3 all approximated or exceeded one standard deviation above the mean (see Table 1). Thus, Zeke demonstrated average to superior phonological processing and print awareness skills. The rhyming and blending instruction he received may have been sufficient for him to capitalize on his preexisting strengths and "discover" how to segment phonemes.

Spring 2003 cohort. Of the four children in the third cohort, Les and Brett exhibited the best response to treatment (see Figure 7). Les needed only eight sessions to achieve mastery of both blending objectives; Brett needed only nine. Although Sandy and Tyrone immediately achieved training criterion for blending recognition, neither did so for blending production (training for these two children was discontinued due to their nonresponsiveness). Les was the only child in this cohort to demonstrate a strong pre- to postinstruction gain in blending production. His average posttreatment probe score was 72.5% correct versus his average baseline probe score of 3.3% correct. Brett made a modest gain; his baseline average was 10% and his posttest average was 45%. Interestingly, Sandy, who was generally unresponsive to intervention, also showed a modest increase in blending production from pretest (0% average) to posttest (50% average). Perhaps if she had continued to receive instruction, she would have demonstrated a substantial increase in her blending abilities (she did show a 20% rise in accuracy during her last training session). Tyrone made no progress in his ability to orally blend phonemes – his pretest and posttest averages were 0% and were identical to his training performance on the blending production objective. As shown in Figure 3, the interobjective blending probe data demonstrate (as discussed previously) that blending recognition performance did not transfer to blending production performance.

As anticipated, all four preschoolers demonstrated mastery-level performance on the rhyming production probes. Both Lyon and Tyrone's baseline and posttreatment averages were 100% accuracy. Sandy's baseline average was 90% and her posttest average was 96.7%, whereas Brett's baseline average was 80% and his posttest average, 87.5%. These levels of performance were obtained on the single interobjective rhyming production probe for three of the four children; however,

Figure 4. Average blending lesson accuracy.



Brett's accuracy dropped to 50% correct. Three of the four children showed no growth in segmentation ability; that is, Sandy, Tyrone, and Brett obtained an average of 0% accuracy on the segmentation production probes administered before, during, and after blending intervention. Les, whose baseline average and interobjective segmentation probe performance was stable at 0% correct, displayed a small average gain of 12.5%.

Spring 2004 cohort. Of the three children in the last cohort, Jacob demonstrated the quickest response to treatment as he required only six sessions to achieve mastery of both blending objectives (see Figure 8). David, on the other hand, required 10 sessions to achieve mastery on both objectives. Although Tara immediately achieved training criterion for blending recognition, she never did for blending production. All three children made modest gains in blending following instruction. Jacob's baseline average was 10% and his posttest average was 70% correct. David's average posttreatment probe score was 50% correct versus his average baseline probe score of 0%. Tara improved from a pretest average of 0% to a posttest average of 53.3%. As was true for the prior cohort, mastery of blending recognition did not influence performance on the blending production interobjective probe.

All three preschoolers essentially demonstrated mastery-level performance on the rhyming production probes. Jacob's baseline average was 96.7% correct and his interobjective probe score and posttest averages were 100% correct. David's baseline average of 83.3% correct dropped across the three baseline probe sessions, but his interobjective and posttreatment performance was stable at 100% accuracy. Tara's baseline average was 73.3% (below mastery level, but she achieved 80% accuracy on the last of the three probes), and her posttreatment average was 80%. None of the children displayed growth in segmentation ability; David, Tara, and Jacob obtained an average of 0% accuracy on the segmentation production probes administered before, during, and after blending training.

Stimulus Effects

Three sets of post-hoc analyses were conducted to examine the relationships between stimulus word characteristics and task performance. In the first set of analyses, we determined whether word frequency was significantly correlated with blending, rhyming, or segmenting production probe performance or with performance on the two blending training objectives. None of the correlations with probe accuracy (whether using percent correct or total phonemes preserved) or training performance reached statistical significance and all correlations were of low magnitude (no greater than .14). Then we used the median splits for word frequency (see Table 2 for medians) to compare performance on each probe task and treatment objective for high- versus low-frequency stimuli. (Levene's test for homogeneity of variances was significant in most cases, so paired samples *t*-tests were adjusted accordingly.) Performance on the rhyming production probe was influenced by stimulus frequency – the preschoolers were able to produce rhyming words for low frequency words with greater ease than for high frequency words ($t = -2.82$, $df = 679.65$, $p < .05$). In contrast, blending and segmenting probe performance was unaffected by stimulus word frequency ($t = -1.23$, $df = 756.07$, $p > .05$ and $t = -1.00$, $df = 728$, $p > .05$, respectively). With respect to blending recognition training, high- and low-frequency words had no differential effect on performance ($t = 0.00$, $df = 358.00$, $p > .05$). However, high-frequency words were easier to orally blend than low-frequency words, but only in Lessons 4-8 ($t = 2.43$, $df = 334.98$, $p < .05$ versus $t = 1.56$, $df = 577.20$, $p > .05$ for blending production Lessons 1-4). This was likely due to floor effects during the first 4 lessons.

The second set of analyses was designed to determine whether stimulus density was significantly correlated with blending, rhyming, or segmenting production probe performance or with performance on the two blending training objectives. Although density was unrelated to blending or segmenting probe performance or to blending training outcomes, it was found to be significantly correlated with rhyming pretest and posttest probe accuracy (*rs* = .17 and .11, respectively). The magnitude of these correlations indicates that the variance in rhyming accuracy explained by stimulus density was negligible. The median splits for word density (see Table 2 for medians) were used to compare performance on each probe task and treatment objective for high- versus low-density items. Just as for word frequency, word density influenced rhyming probe accuracy ($t = 2.82$, $df = 679.65$, $p < .05$) but not blending or segmenting probe accuracy ($t = -0.17$, $df = 758$, $p > .05$ and $t = 0.22$, $df = 728$, $p > .05$, respectively). In this case, the children were able to generate rhymes for high-density words more easily than for low-density words. With respect to blending recognition training, high- and low-density words had no differential effect on performance ($t = -0.54$, $df = 358$, $p > .05$). However, low-density words were easier to orally blend than high-density words, but only in Lessons 4-8 ($t = -2.55$, $df = 334.82$, $p < .05$ versus $t = -0.78$, $df = 578$, $p > .05$ for blending production Lessons 1-4). Once again, this was likely due to floor effects during the first four lessons.

Finally, we examined the relationships between density and probe accuracy and training outcomes while holding frequency constant. On the probe tasks, stimulus density was significantly and positively correlated

Figure 5. Results for 2000 cohort.

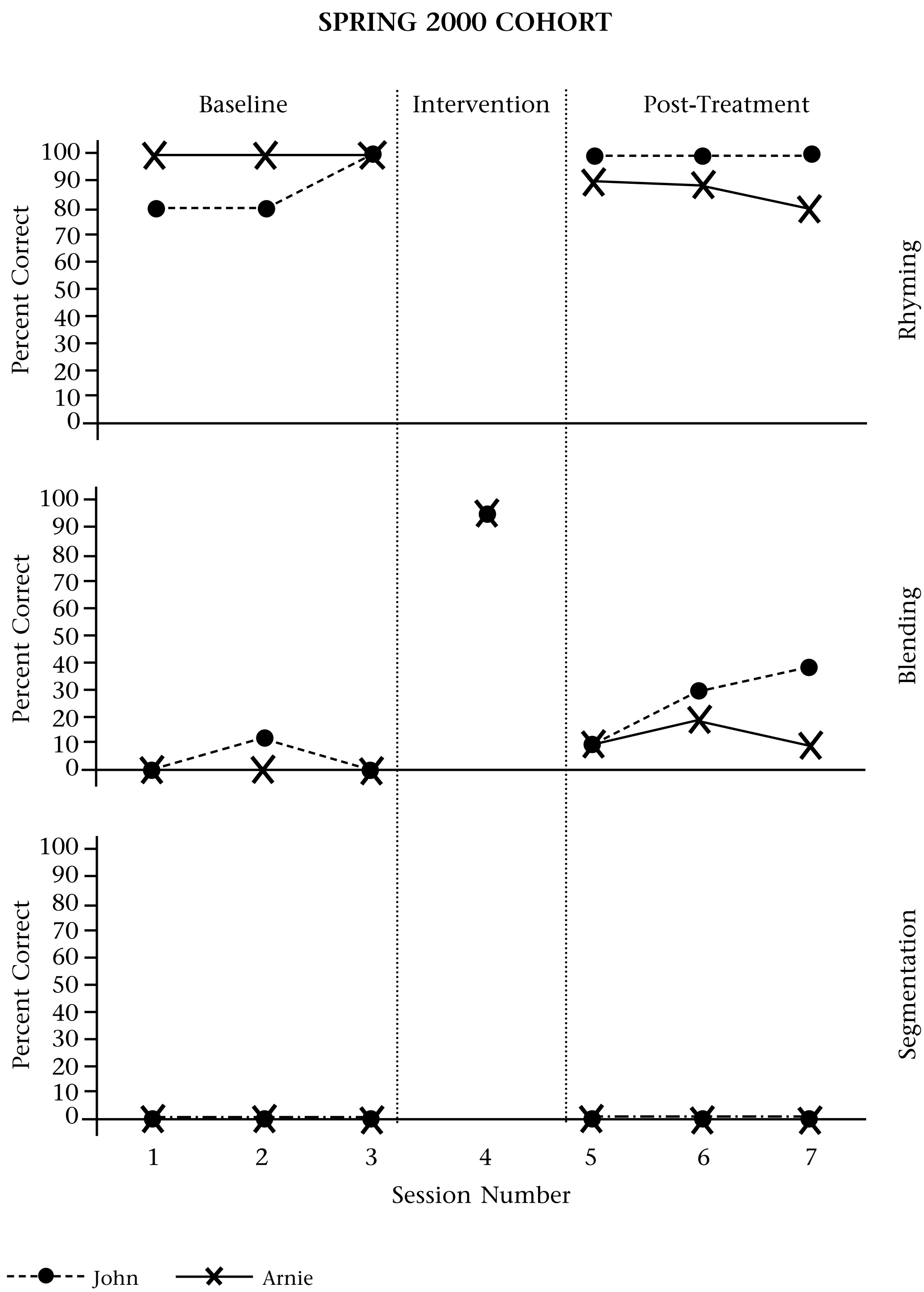


Figure 6. Results for 2001 cohort.

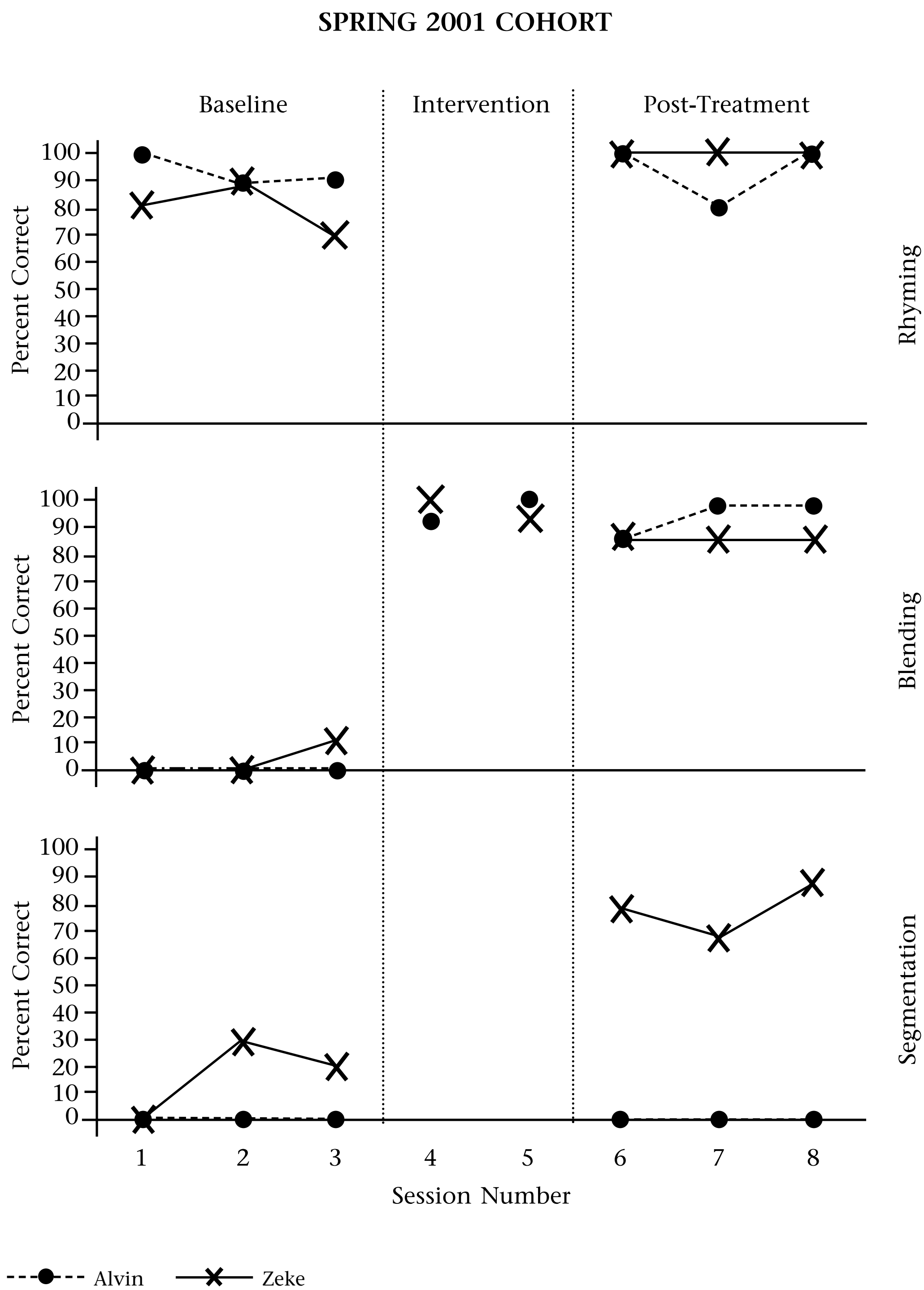


Figure 7. Results for 2003 cohort.

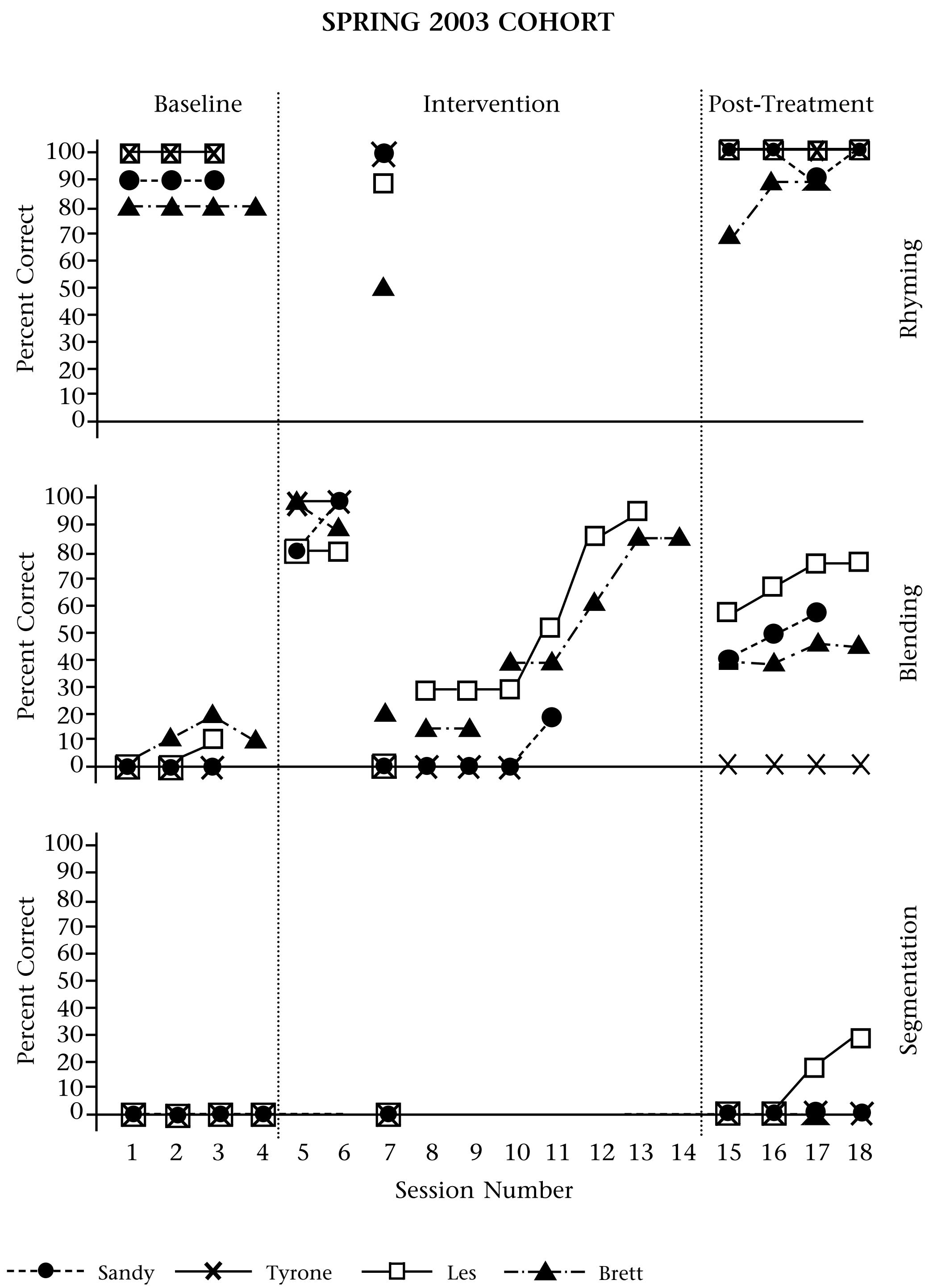
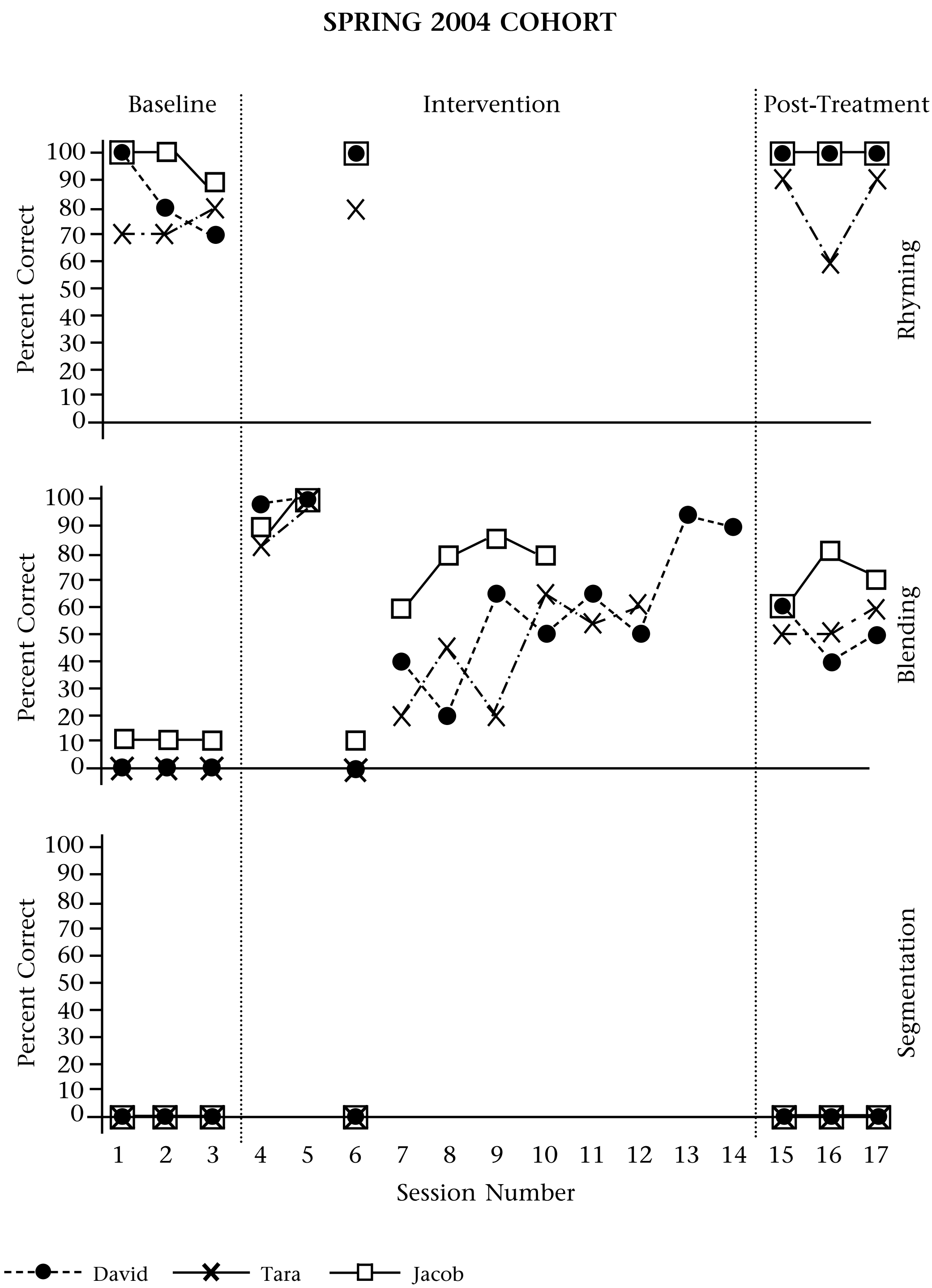


Figure 8. Results for 2004 cohort.



with rhyming accuracy (r = .16), but not blending or segmenting accuracy. On the training objectives, density was unrelated to blending recognition performance, but was significantly correlated with blending production performance. Specifically, density was associated with blending performance in Lessons 1-4 (r = -.07) and Lessons 4-8 (r = -.10). Applying median splits, low-density words were related to stronger blending accuracy during instruction in Lessons 1-4 (r = .11) and Lessons 4-8 (r = .19), whereas high-density words were related to weaker training performance in Lessons 4-8 (r = -.17), though not Lessons 1-4.

DISCUSSION

The primary purpose of this study was to examine the efficacy of the blending module of PASS (Roth et al., 2002), a phonological awareness program developed specifically for preschool children with speech and language impairments. A secondary aim was to conduct a post-hoc examination of the influence of stimulus effects on phonological awareness learning as an indirect test of the predictions of the lexical restructuring hypothesis. Our findings are discussed with respect to these two goals and their implications for practice and future research.

Response to Blending Intervention

The results indicate that the PASS blending program, implemented in conjunction with systematic training in the alphabetic principle, was an effective approach to phonological awareness instruction for the preschool children in our sample. Moreover, the blending treatment effects were localized, which is consistent with the findings for the rhyming module of PASS (Roth et al., 2002) and with others' work (e.g., Fox & Routh, 1976; Slocum, O'Connor, & Jenkins, 1993; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993). Ten of the 11 children demonstrated no substantial improvement in the untrained area of segmentation. Thus, the three phonological awareness behaviors we assessed (rhyming, sound blending, and sound segmentation) were functionally independent, which was an essential requirement for demonstrating treatment efficacy within our multiple-baseline research design. This suggests that the blending intervention was the primary contributor to gains in phonological awareness among our preschoolers. Although training in one area of phonological awareness might transfer to other areas given the right set of circumstances (e.g., Slocum et al., 1993; Torgesen, 2000), our results suggest this cannot be presumed.

All children showed significant improvement in their receptive blending ability (blending recognition), with the group average exceeding the training criterion of 80% accuracy over two sessions. Further, the children learned the task quickly, needing no more than two lessons to attain mastery. This is not surprising because the blending recognition task simply required attention to a single phoneme within a word to select the correct picture. As expected, blending production was more difficult because it required synthesizing three individual sounds to generate a word (e.g., /n/-/o/-/z/ = nose). The group averaged a 49% gain in overall correct responses from pretest to posttest, which represented a large treatment effect (ES = 2.87). However, overall accuracy may not be the best gauge of the extent of learning that occurred. Instead, the number of phonemes preserved in target words seems to be a more sensitive measure. At pretest, the children in our sample attained an overall average of about 3% accuracy in blending performance but preserved one or more phonemes for one third of the stimuli. At posttest, they attained an overall average of about 52% accuracy but preserved one or more phonemes for approximately 89% of the stimuli. Based on these data, it would appear that number of phonemes preserved is a more robust indicator of task performance and skill acquisition; simply relying on accuracy data may underestimate children's true progress in both research and educational settings.

The pattern of learning demonstrated by the preschoolers in this study is noteworthy. Training on blending recognition did not transfer to blending production, which is clear in the children's performance on the interobjective blending production probe administered prior to the initiation of blending production instruction (i.e., average of 2.7% accuracy at pretest versus 4.3% accuracy between treatment objectives). Rather, explicit instruction in orally blending phonemes was required to improve their performance. Similar to other areas of language learning, spontaneous generalization cannot be assumed to occur for children with speech and language impairments (e.g., Leonard, 1998). Systematic, intensive, and focused instruction is necessary to help children learn and practice newly acquired skills, such as blending, at each level of task difficulty (i.e., recognition and production). Likewise, the amount of training was an important variable. After four blending production sessions (2 hours of training), the children attained an accuracy rate of less than 40%; after eight sessions (4 hours of training), their accuracy rate nearly doubled to 75%. These findings underscore the need to examine length of intervention when documenting treatment efficacy in preschool populations.

Closer inspection of individual children's progress revealed inconsistencies in their responsiveness to intervention. Two children achieved mastery (80% accuracy) in blending production at posttest, and another six made modest improvements (an average gain of about 53% accuracy) but did not achieve mastery. Nevertheless, when we examined the percentage of nonoverlapping data points (PND; Faith, Allison, & Gorman, 1996) between pretest and posttest blending performance, most of the children in the sample did make notable progress in sound blending ability (higher PND values represent stronger treatment effects; a threshold of about 80% PND is desirable). Three of the four cohorts exhibited a strong response to blending instruction: PND for the first cohort was 50%, 100% for the second and fourth cohorts, and 79% for the third cohort. Interesting, we did not observe a clear response pattern based on the children's speech and language profiles. Three of the children in our sample were clinically diagnosed with expressive phonology disorder, 4 with language impairment, and 4 with combined speech and language disorders. In each of these groups, there was one child who made very little or no progress in blending production and, in two of the three groups, one child attained mastery. The absence of an association between learning and child communication characteristics is consistent with our previous findings for rhyming instruction (Roth et al., 2002). Lewis et al. (2000) did find that children's disability profiles were related to their long-term outcomes in literacy-related skills. However, a direct comparison between our study and theirs is not possible because we did not follow our sample longitudinally, and their study did not incorporate an experimental intervention.

Stimulus Effects

With respect to probe performance, we found that word frequency had a significant effect on rhyming production but not on blending or segmenting production. Low-frequency words were easier to rhyme than high-frequency words. Likewise, ND had a significant effect on rhyming probe accuracy, but was unrelated to performance on the blending or segmenting probes. Specifically, children were able to produce rhymes for high-density words with greater success than for low-density words. With respect to blending training performance, we found that word frequency and ND were unrelated to blending recognition, but were related to blending production. Specifically, high-frequency were easier to orally blend than low-frequency words, whereas high-density words were more difficult to blend than low-density words.

Our findings regarding the influence of ND and word frequency on phonological awareness task performance are partially consistent with the extant literature. Thus, the effects of ND on rhyming probe performance were expected based on the lexical restructuring model and existing research with typically developing children (DeCara & Goswami, 1999; Metsala, 1999). However, the inverse relationship between word frequency and rhyming performance accuracy was unanticipated. Prior research has established that it is easier to perform phonological awareness tasks such as rhyming and blending with high-frequency words than low-frequency words (e.g., Troia, Roth, & Yeni-Komshian, 1996). Moreover, there was a strong positive correlation of .66 between frequency and ND in our stimulus set for the rhyming probe (this is also consistent with the literature; see Storkel, 2004), making the contrast in findings for frequency and density perplexing. Even considering that the low-frequency words in the rhyming stimulus set were relatively high in frequency (based upon the median frequency of 52.73) compared to all other stimulus sets for probe tasks and intervention, the direction of the relationship between word frequency and rhyming performance is not readily explainable. For the segmenting probe, floor effects most likely accounted for the absence of a relationship between ND or word frequency and probe task performance. For the blending probe, we have no clear explanation for why neither ND nor word frequency had an effect on children's performance; however, it is interesting to note that the stimuli for this probe task were generally lower in frequency than any other stimuli used.

With respect to blending training performance, it is not surprising to find that frequency and ND were not associated with blending recognition performance because the children performed at or near ceiling on this objective. The inverse relationship between ND and blending production performance is counter to the expected findings, although the expected positive association between word frequency and training performance was observed. Because frequency and ND were negatively correlated for these treatment stimuli (r = -.55), more high-frequency words resided in sparse neighborhoods whereas more low-frequency stimuli resided in dense neighborhoods.

Our discrepant findings might be an artifact of an interaction between frequency and ND. Newman and German (2002) reported results from an experimental study in which words within a single dense lexical neighborhood appeared to compete with each other for access and retrieval, such that words higher in frequency than the target word interfered with the successful retrieval of the target, reducing overall naming accuracy. There is also the possibility that factors other than word frequency and ND mediate lexical retrieval, such as neighborhood frequency (average frequency of occurrence of all words within a neighborhood) and phonotactic probability (frequency of sound sequences within a given word). Though neighborhood frequency and phonotactic probability are strongly related, they have been shown to be distinct from each another and from ND (Pylkkanen, Stringfellow, & Marantz, 2002). We did not account for these additional variables in our analyses and, because we examined the influence of ND and word frequency post hoc, we did not systematically select words of varying frequency within particular neighborhoods. However, most of the developmental ND research also is based on convenience samples of vocabulary words; thus, our approach to analyzing the effects of ND on phonological awareness represents the most common methodology.

Alternately, the observed discrepancies may be due to the characteristics of the children in our sample. To our knowledge, this investigation represents the first test of the hypothesized effects of lexical restructuring on the phonological awareness performance of preschoolers with speech and language impairments. Lexical restructuring was originally theorized to account for vocabulary learning and phonological awareness in typical language learners. Our findings raise the question of whether lexical restructuring has the same explanatory power for phonological awareness performance in young children with disordered speech and language. Exploration of this question requires deliberate manipulation of word frequency and ND in typical and disordered populations. Pursuing this line of research is important because there may be implications for selecting stimuli for phonological awareness training (and possibly other areas of language instruction).

Study Limitations

Several important qualifications to our findings must be considered. First, our blending recognition task did not require genuine blending. Nevertheless, it was a critical first step to teaching blending to preschoolers with communication disorders. Possibly, an intermediate receptive blending task like judging if a fully segmented word matched an illustration would have better approximated true blending and yielded generalization to production, though learning transfer is typically difficult for these youngsters anyway.

Second, we did not evaluate the effectiveness of blending training in isolation, which would have been a cleaner assessment of the PASS blending module's efficacy; all children received rhyming instruction prior to participating. Prior rhyming treatment may have affected response to blending recognition training simply because the recognition task involved attending to a single sound, which is somewhat similar to attending to the rime portion of a word. Though none of the children demonstrated blending production ability before intervention (they showed an average of about 3% accuracy on pretest probes), it is not possible to determine the precise contribution of rhyming ability to the blending treatment outcomes without an evaluation of pretreatment blending recognition performance.

Third, the stimulus characteristics of word frequency and ND were identified post hoc and thus were not experimentally manipulated. This made it more difficult to identify the separate and combined effects of these lexical characteristics on phonological awareness performance and responsiveness to intervention.

Fourth, word frequency was based on data from Carroll et al. (1971), which were generated from written materials for older children, and thus may not be an applicable lexical measure for very young nonreaders. Likewise, the traditional method for calculating ND based on the lexicon of the language rather than an individual's lexicon may be inappropriate for young children whose vocabularies are unlikely to include all items within a neighborhood. Nevertheless, precedent exists for calculating word frequency and ND using these procedures (German & Newman, 2004; Storkel, 2004) for research with the preschool population and permitted us to make comparisons with other investigators' findings.

Implications for Practice

This investigation provides evidence that the blending module of the PASS program is an effective intervention for weak sound synthesis skills in young children with communication disorders. The efficacy of the rhyming training module has already been established (Roth et al., 2002), and we are currently evaluating the effectiveness of the third and final module of PASS, sound segmentation, with the same population of children. An intervention program such as PASS that is capable of helping young at-risk children achieve substantial gains in phonological awareness may reduce their susceptibility for later literacy learning difficulties, but longitudinal studies to identify the long-term effects of PASS on phonological awareness as well as early reading and writing skills in children with speech and language impairments are needed to test this hypothesis.

Clarification of the variables that differentially affect responsiveness to intervention is critical to practitioners, given that 2-6% of children can be expected not to benefit substantially from phonological awareness training (cf. Torgesen, 2000). Based on our findings and the work of others, stimulus characteristics such as word frequency and ND, and possibly others, may have a notable influence on children's performance on at least some phonological awareness tasks. Little research in this area has systematically examined the effects of stimulus selection on treatment outcomes, but this is a fruitful area of exploration to help explain why some children do not seem to respond as well as others to intervention.

Finally, our findings suggest that treatment resisters may display more growth in phonological awareness following treatment than is commonly thought possible based on the outcome measure used. Response accuracy may be too cursory a measure for identifying small increments of change. The proportion of phonemes preserved might be a more sensitive progress indicator and ultimately serve as a curriculum-based measure similar to correct letter sequences. Further research is required to explore this possibility.

APPENDIX

Probe Stimuli

Rhyming	***Sound Segmentation***	***Sound Blending***
A. cook (demonstration item)	A. sheep	A. cute
B. by (practice trial item)	B. pot	B. nose
1. took	1. sock	1. bake
2. go	2. moon	2. hood
3. brother	3. leaf	3. ten
4. chew	4. wig	4. ship
5. sipping	5. bush	5. moose
6. fire	6. time	6. hope
7. nickel	7. gate	7. kite
8. honey	8. jar	8. pig
9. please	9. cab	9. fudge
10. jam	10. house	10. lamb

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