

The Effects of Direct Instruction on the Single-Word Reading Skills of Children Who Require Augmentative and Alternative Communication

Karen A. Fallon
Indiana University of Pennsylvania

Janice Light
David McNaughton
Kathryn Drager
Carol Hammer
The Pennsylvania State University,
University Park

Current literature suggests a lack of empirically validated strategies for teaching reading skills to children who use augmentative and alternative communication (AAC). The current study implemented a single-subject, multiple-probe-across-subjects design to investigate the effects of direct instruction in single-word reading on the performance of students who use AAC. The instructional program targeted the reading skills of 5 participants who had severe speech impairments and ranged in age from 9 to 14 years old. All 5 participants reached criterion for matching targeted written words to corresponding pictures. Three of the 5 participants demonstrated generalization of reading skills to novel-word reading, and 4 of the 5 generalized reading skills to book contexts. Implications and directions for future research are discussed.

KEY WORDS: augmentative and alternative communication, children, literacy, direct instruction, reading

Literacy skills are of tremendous importance for all children; however, for those who require augmentative and alternative communication (AAC), the ability to read and write is integral in providing access to a full range of AAC systems. Children with severe communication disabilities who do not acquire literacy skills are unable to utilize AAC systems based on traditional orthography (i.e., systems that use letters, words, and phrases) and therefore may be restricted from opportunities to participate in educational, vocational, and community settings (e.g., Foley, 1993). With data to suggest that 85% of jobs require a reading level of Grade 9 or above (Taylor, 1989), literacy skills are crucial to the successful preparation of these individuals for employment, successful participation in the community, and, ultimately, independent living.

Despite the vital importance of learning to read and write, the research literature consistently reports that many individuals with severe speech impairments do not develop functional literacy skills (e.g., Foley & Pollatsek, 1999). Although some individuals who use AAC do acquire reading skills, the research literature repeatedly suggests that individuals with severe speech impairments tend to demonstrate weaker

reading skills than their age-matched peers and, further, that these weaknesses frequently persist into adulthood (e.g., Koppenhaver & Yoder, 1993).

Given a consistent research base suggesting poor literacy outcomes for many individuals who use AAC, paired with a general lack of AAC research to suggest appropriate reading instruction, it is important to investigate effective practices for teaching reading to individuals with severe speech impairments. In order to develop appropriate instructional programs for individuals who use AAC, reading instructors must consider two primary issues: (a) the content of a beginning reading program (i.e., what to teach) and (b) the principles of effective reading instruction (i.e., how to teach).

Beginning Reading Instruction: What to Teach

Becoming a skilled reader is a developmental journey that involves continual acquisition and refinement of several interrelated skills (Adams, 1990; Farstrup, 2002). Current literature suggests that a balanced, comprehensive reading program should include instruction in the areas of alphabets, reading fluency, vocabulary, and text comprehension (e.g., National Institute of Child Health and Human Development [NICHD], 2000). Although several skills play an important role in the reading learning process, beginning reading instruction must target the building blocks that will lay the foundation for ongoing reading skills development (e.g., Adams, 1990; Simmons & Kameenui, 1998). To provide a solid base for reading achievement, the current research literature (e.g., Simmons & Kameenui), including the National Reading Panel report (NICHD, 2000), emphasizes the importance of teaching beginning readers essential alphabetic system knowledge in two specific areas: phonemic awareness (i.e., explicit awareness of the sound structure of words) and phonics instruction (i.e., the understanding of the relationships between graphemes/letters and phonemes/sounds).

A large body of literature lends strong support for a reading instruction program designed to promote phonemic awareness (e.g., Adams, 1990; Simmons & Kameenui, 1998). The research literature consistently describes phonemic awareness skills as critical and fundamental to the acquisition of reading skills (e.g., Catts & Kamhi, 1999). Numerous studies with children who do not have severe communication disabilities have established a positive correlation between strong phonemic awareness skills and successful literacy development (e.g., Adams, 1990; Ehri et al., 2001). In addition, the literature repeatedly suggests that phonemic awareness skills can be successfully taught to typically developing children (e.g., van Kleeck, Gillam, & McFadden, 1998),

as well as to children with reading disabilities (e.g., Hatcher, Hulme, & Snowling, 2004; O'Connor, Jenkins, Leicester, & Slocum, 1993; van Kleeck et al., 1998). Studies investigating phonemic awareness instruction consistently report gains in phonemic awareness skills to be positively correlated with improved reading success in both typically developing and disabled readers (e.g., Adams, 1990).

Increasingly, research has begun to focus on phonemic awareness and its relationship to reading development in individuals who require AAC (e.g., Blischak, 1994; Sandberg, 2001). As reported in the literature concerning reading acquisition in speaking children, the AAC literature suggests the critical importance of phonological awareness skills for children with severe speech impairments who are learning to read (e.g., Nelson, 1992). Studies that have examined the phonemic awareness performance of individuals who use AAC consistently report that a total absence of natural speech does not preclude individuals from developing phonemic awareness skills (Bishop & Robson, 1989; Foley, 1993; Vandervelden & Siegel, 1999). However, some studies do suggest a positive relationship between articulation abilities and phonemic awareness (i.e., the greater the articulation abilities of an individual, the better phonemic awareness skills tend to be; Foley, 1993; Foley & Pollatsek, 1999; Sandberg, 2001).

Chall (1967) emphasized the necessity for systematic, explicit phonics instruction for beginning readers. Consistent with Chall's recommendations, current research data indicate the critical need for phonics instruction in the early stages of reading development (e.g., Adams, 1990; Cunningham & Cunningham, 2002; NICHD, 2000). The research data indicate that systematic, explicit phonics instruction is more effective than inconsistent phonics programs but that no one approach is more effective than another (Cunningham & Cunningham; NICHD). Instructors can use a variety of phonics teaching methods that will contribute to early reading success (Cunningham & Cunningham; NICHD). For example, one empirically validated approach to phonics instruction, synthetic phonics, teaches children to convert individual letters to sounds and then to blend the sounds together to form words (NICHD). The National Reading Panel report also emphasizes that regardless of the approach used, phonics instruction must involve a component that provides opportunities for children to use their knowledge of letter-sound relationships to decode words.

Although the AAC literature has addressed several skill areas necessary to the reading acquisition process (e.g., phonological awareness), to date there are few research studies that have described the acquisition of decoding skills by individuals who require AAC.

Beginning Reading Instruction: How to Teach

With empirical evidence to suggest the essential content of a beginning reading program, instructors must next consider the instructional design and methods that will best facilitate reading learning. Ellis, Worthington, and Larkin (1994) presented a synthesis of principles for effective teaching and instructional design derived from empirically validated research studies. Ellis et al. suggested that students have a greater tendency to become independent, self-regulated learners when instruction (a) is carefully scaffolded (i.e., external supports in the form of adult cues or materials are provided), (b) is strategic (i.e., teaches students "how to learn"), (c) involves direct teaching, and (d) is made explicit. Consistent with the findings of Ellis et al., several studies that have investigated beginning reading indicate the benefits of a "code-emphasis" beginning reading program that uses systematic, direct instruction to explicitly teach letter-sound connections and decoding skills (e.g., Chall, 1996; Simmons & Kameenui, 1998).

Although there are consistent data to suggest the essential content of a reading program, specific guidelines for carrying out the instruction remain a critical gap in the AAC research literature. Individuals who require AAC present many unique challenges in designing effective reading instruction, because (a) they cannot use natural speech to sound out words and receive articulatory feedback (e.g., Foley, 1993), (b) they may have a limited experiential base to support the learning process (Light & Kelford Smith, 1993), (c) they may not have the receptive language base necessary for comprehending written language (e.g., Nelson, 1992), and (d) instructors may have significant difficulty observing and evaluating reading skill development given the students' inability to respond orally (e.g., reading aloud, repeating sounds; Blischak, 1994; Nelson, 1992).

To accommodate these unique needs, the literature on speaking children can provide insight into effective instructional practices. It is necessary, however, that the teaching strategies be significantly adapted to meet the needs of individuals with severe speech impairments. The reading instruction tasks must adhere to established teaching principles, yet compensate for the limited

speaking capabilities that preclude individuals who use AAC from responding orally to training tasks (e.g., repeating sounds, reading aloud). As these task modifications may impose different cognitive and linguistic demands on learners, it is important to conduct research studies to investigate the effects of task changes and to validate the usefulness of task modifications.

The current study investigated the effects of direct instruction on the single-word decoding skills of individuals with severe congenital speech impairments. Specifically, the following research questions were investigated: (a) Will direct instruction designed to teach single-word reading improve the performance of individuals with severe speech impairments for reading targeted VC and CVC words that contain target letter-sounds? (b) Will single-word reading skills generalize to novel VC and CVC words that include target letter-sounds? (c) Will reading skills generalize to single-word reading of targeted VC and CVC words in book-reading activities?

Method Participants

Five children (4 boys and 1 girl) ranging in age from 9;5 (years;months) to 14;0 ($M = 11;0$) participated in the study. All of the participants were from lower-middle to middle-class socioeconomic backgrounds and attended schools in rural central Pennsylvania. All students were placed in self-contained special-education classrooms. See Tables 1 and 2 for specific descriptive information concerning the demographics, speech intelligibility, and literacy skills of each participant. In order to protect the confidentiality of the participants, pseudonyms have been used.

The participants for this study were recruited from schools in central Pennsylvania by requesting nominations from teachers, speech-language pathologists, and families via phone contact and direct mailings. The selection criteria used to identify potential candidates required that individuals (a) be at least 6 years of age; (b) present with a severe congenital speech impairment (i.e., less than 30% speech intelligibility at the single-word level); (c) demonstrate the ability to identify at least 60%

Table 1. Demographic information for participants.

Participant	Age (years;months)	Gender	Disability	Speech intelligibility (%)	Communication modes
Dale	11;9	M	Mental retardation	25	Natural speech, gestures, DynaMyte
Sam	14;0	M	Mental retardation	20	Natural speech, gestures, Liberator
Tommy	9;11	M	Cerebral palsy	30	Natural speech, gestures
Amy	10;3	F	Cerebral palsy	25	Natural speech, gestures
Nate	9;5	M	Down syndrome	10	Natural speech, gestures, DynaMyte

Table 2. Speech intelligibility and linguistic skills of participants.

Participant	Single-word speech intelligibility (%)	PPVT-III standard score	TACL-3 standard score	Target letter knowledge (%)	Target letter-sound knowledge (%)	Target vocabulary knowledge (%)
Dale	25	47	57	100	100	90
Sam	20	50	68	100	100	94
Tommy	30	40	57	100	100	78
Amy	25	71	72	100	100	96
Nate	10	44	57	86	71	74

Note. All percentile ranks were <1, with the exception of Amy, who scored in the 3rd percentile for both the PPVT-III (Peabody Picture Vocabulary Test—Third Edition; Dunn & Dunn, 1997) and the TACL-3 (Test for Auditory Comprehension of Language—Third Edition; Carrow-Woolfolk, 1999).

of the line drawings representing vocabulary words included in the intervention program and 100% of line drawings following preintervention training; (d) demonstrate the ability to identify a minimum of 50% of target letters when named (i.e., *p, b, n, m, t, g, s, l, r, e, i, a, o, u*) and 100% of target letters following preintervention training; (e) demonstrate the ability to identify a minimum of 50% of the sounds that corresponded to target letters and 100% of sound-letter correspondences following preintervention training; (f) have normal vision and hearing acuity; and (g) have parental permission and support to participate in the project. Prior to beginning intervention, all candidates who did not demonstrate the ability to identify 100% of the line drawings, target letters, and/or target sound-letter correspondences received training until the 100% criterion was reached. The preintervention training followed the same procedures as those used for the intervention training and required participants to point to correct responses from a field of four. Once 100% accuracy was achieved for accurate identification of vocabulary, letters, and letter-sound correspondences, candidates became eligible for participation in the project. All 5 participants used their index fingers to directly select their responses (e.g., pointing to pictures). In addition, participants had their AAC devices available to them to provide opportunities for them to ask questions or interact with the instructor.

As specified in the selection criteria, participants all presented with severe speech impairments characterized by single-word speech intelligibility of 30% or less with unfamiliar partners. Speech intelligibility was assessed using stimulus words from the Index of Augmented Speech Comprehensibility in Children (Dowden, 1997). To assess speech intelligibility, unfamiliar listeners transcribed audiotapes containing words produced by potential participants. The number of correct words divided by the total words was then used to determine intelligibility levels. All participants were randomly selected from the list of eligible candidates.

Materials

All instructional stimuli were based on 14 targeted letters and their corresponding sounds (i.e., letter-sounds that were used in the instructional program); these letters were selected based on their potential to be combined into concrete, depictable VC and CVC words. The following letters were introduced in a sequence according to their auditory and visual dissimilarity and presented in lowercase format: the vowels (*a* as in *apple*, *e* as in *egg*, *i* as in *ill*, *o* as in *mop*, and *u* as in *up*) and the consonants (*m, n, b, p, t, g, r, l, s*). These 14 target letter-sounds were used to generate a corpus of 75 VC and CVC words.

All instructional stimulus lists and probe lists were compiled from the corpus of 75 target words that were randomly distributed between two lists: a 50-word corpus of targeted words and a 25-word corpus of novel words. (See the Appendix for stimulus lists.) Word lists were constructed with consideration of the following principles described by Carnine, Silbert, and Kameenui (1997): (a) separate letters that are auditorily or visually similar, (b) introduce more useful letters before less useful letters (i.e., letters more commonly used in simple words), and (c) vary sounds when constructing word lists (i.e., no 2 words with the same initial, medial, or final sound shall follow each other). All target words contained two to three sounds but included up to four letters (e.g., *pill*).

To create the stimuli for instructional and probe tasks, 3-in. × 3-in. pictures of target words and written stimulus words were created using the line drawings and text available on Boardmaker Software Version 3.5.¹ Only stimuli for the reading tasks included written words under the pictures. All picture choices were presented in fields of four on 8.5-in. × 11-in. stimulus cards (i.e., three foils and one target). The placement of foil and target pictures was rotated on each stimulus card

¹Boardmaker software is a graphics database used for creating communication displays, using picture communication symbols in clip art form. Boardmaker software is manufactured by Mayer-Johnson (www.mayer-johnson.com).

to ensure that target words appeared in a variety of positions. All picture stimuli were laminated to protect against potential damage and to facilitate easier handling of the cards by the instructor and participants. A plastic copy stand was used to display the laminated stimulus cards during tasks.

Design and Procedures

The present study implemented a single-subject, multiple-probe-across-subjects design with 5 participants (McReynolds & Kearns, 1983). At least three baseline sessions were conducted with each participant until a stable baseline was observed. In order to reduce the amount of time each participant remained in baseline phase before intervention began, intervention was implemented across one set of 3 participants, with replication across a second set of 2 participants.

Instruction

The reading instruction program consisted of three components: (a) matching single sounds to the initial sound of words, (b) telescoping sounds into words, and (c) reading single VC and CVC words. The instructional tasks and procedures were based on those proposed by Carnine et al. (1997) for use with children who do not have severe communication disabilities. The tasks and procedures were adapted so that they did not require spoken responses from the participants.

A full instructional session included training on the following: (a) one 5-word list for initial phoneme matching, (b) one 5-word list for telescoping, and (c) one 5-word list for single-word reading. In total, each instructional session targeted 15 different words, 5 for each instructional task. Throughout the instructional program, a correction procedure was used to address incorrect responses by providing explicit instruction on incorrect items. The correction procedure involved a model-prompt-check sequence in which the instructor provided an explanation of the correct response (i.e., model), led the student in making a correct response (i.e., prompt), and, finally, provided the student with an opportunity to select the correct response independently (i.e., check). Positive verbal feedback was provided throughout the training program both to praise correct responses and to motivate students to continue participating in sessions.

Phonological awareness tasks. Tasks and procedures incorporated into the phonological awareness phase were adapted from several empirically based sources, including intervention studies that investigated the effectiveness of phonological awareness instruction (O'Connor et al., 1993; van Kleeck et al., 1998) and the work of

Carnine et al. (1997). To teach phonological awareness skills, each session incorporated words composed of target sounds into a series of two activities: matching phonemes to initial sounds in single words (van Kleeck et al., 1998) and telescoping/blending individual sounds into words.

In the initial sound-matching activity, the instructor first verbally labeled each of the four picture choices, then produced a single phoneme, and then labeled each of the pictures a second time. The participant was then asked to select the picture of the word that started with the target sound. Each of three foils contained a different initial phoneme (e.g., *mop*, *cup*, *net*, *sun*). During the telescoping task, the instructor slowly produced the series of individual sounds that composed target words. Participants were then asked to identify the target word from a series of four pictures (i.e., one target and three foils). Response foils were constructed according to the following guidelines: (a) one foil contained a different initial consonant, (b) one foil contained a different vowel, and (c) one foil contained a different final consonant. For example, for the target word *man*, the foils included *pan*, *men*, and *mat*.

Single-word reading. Consistent with the principles of direct instruction, the single-word reading training was designed to promote errorless learning of a new skill by including both introductory and guided practice formats (e.g., Carnine et al., 1997). The single-word decoding instruction contained three instructional levels: (a) an introductory format in which the instructor modeled the skill (i.e., instructor tracked each letter with an index finger while slowly and continuously reading the word letter by letter, then read the word at a normal rate while tracking the letters), (b) a guided-practice format in which the student was given the opportunity for structured practice with some assistance from the instructor (i.e., used the same procedures as modeling, except that the student selected the correct corresponding picture with the instructor), and (c) a trial format in which the child received no help from the instructor (i.e., the student independently tracked the letters of the written words with an index finger, then pointed to the correct picture). In each session, all three instructional formats were used with one 5-word list (i.e., three trials per target word, progressing from maximal to minimal levels of instructional support). Each trial involved the presentation of a single written word, highlighted in yellow, at the bottom of a stimulus card containing four line-drawn pictures, one of which depicted the target word. Response foils were constructed according to the same procedures as those used for telescoping.

The stimulus lists were developed with a progression of target sounds introduced incrementally within target words. Initially, eight target letters (i.e., *a*, *e*, *o*,

n, t, p, r, m) were introduced in the first three training lists, with the remaining six sounds introduced in two increments of three in subsequent training lists. The training lists were balanced for words that began with continuant sounds (e.g., *sun, on*) and stop sounds (e.g., *pat, big*). Initial training lists were more heavily weighted for words that began with continuant sounds as they are easier for beginning readers to decode (Carnine et al., 1997). In the next three training lists, three additional letter-sounds were introduced (i.e., *i, l, s*) with lists again balanced for initial stops and continuant sounds. The final four training lists introduced the remaining three target sounds (*u, b, g*). Lists were introduced sequentially beginning with the first reading training list and progressing to the final training list. Participants were required to demonstrate 80% accuracy (i.e., 4 of 5 words correctly read) on all lists of an instructional level before progressing to the next level of difficulty (i.e., new letters were not introduced until the participant demonstrated proficiency for reading words containing the first and second set of letters, respectively).

Generalization

To determine if students were able to generalize single-word reading for targeted words to reading of novel, single words, participants were asked to read words that had not been included in the instructional program but were composed of target letters. Two generalization probes for novel words were conducted after participants had reached criterion for targeted words.

Measures of single-word reading during a book-reading activity were gathered to determine generalization of reading skills to contextual reading activities. Books from the *I Spy* series (i.e., books containing assorted photograph collages) were adapted for the activity by substituting the book text with the carrier phrase "I spy a ..." followed by a target word highlighted in yellow. During book-reading probes, the instructor read the carrier phrase, then paused and looked expectantly at the participant while pointing at the target word. The instructor then prompted the participant to find the picture of the targeted word. To compensate for the complexity of the picture collages, the picture field was narrowed using a paper barrier with a window cutout that revealed one quarter of the picture collage (i.e., "the magic window").

Measures

The effectiveness of the reading instruction program was evaluated through probes of the dependent and generalization measures. The dependent measure was the

number of targeted single VC and CVC words containing targeted letter-sounds read correctly. Two generalization measures included the number of novel, single words that contained targeted letters read correctly and the number of targeted words read correctly in book contexts. Data on the dependent measure were collected during baseline phase and through repeated probes during the training period. Probes to measure reading of targeted words consisted of 10 words per probe and were collected every two sessions at the beginning of the instruction. Criterion for reading of single targeted words was set at 80% accuracy over two consecutive sessions.

Using a posttreatment multiple-generalization probe design (Schlosser, 2003), generalization measures for reading of novel words were collected after the participant had reached criterion for reading of targeted words. Ten-word probes of targeted words in book contexts were gathered every four sessions at the beginning of instructional sessions throughout the instructional program. Word lists for use in all probes were randomly assigned so that each of the five probe lists occurred once every five sessions.

Measures taken during baseline phase and through probes during the instructional program were analyzed for the accuracy of single-word reading skills. A response was considered correct if the student clearly pointed to the picture that accurately corresponded to the written target word. If the participant selected one of the foils, the answer was recorded as incorrect and the selected foil was recorded. If the participant pointed to more than one answer, the first item was scored as the participant's choice.

Maintenance

Maintenance probes were conducted 2 weeks, 1 month, and 2 months after instruction was completed to determine whether newly learned skills were maintained over time once the instruction ceased. Probes were conducted to measure maintenance of the dependent variable (i.e., reading of targeted single words) and the two generalization measures (i.e., reading of targeted single words in book contexts and reading of novel, single words). All maintenance measures consisted of 10-word probe lists.

Procedural Integrity

The instructor was trained on all instructional procedures before starting instruction. Training continued until the instructor reached 90% compliance with the standard instructional procedures. To ensure the integrity and consistency of training procedures, all instructional sessions were videotaped. Approximately 20% of

sessions were randomly selected and evaluated by an individual trained in the instructional procedures. The rater evaluated sessions for compliance by the instructor with the instructional procedures specific to each instructional task (i.e., initial phoneme matching, telescoping, and single-word reading). A procedural reliability score was determined by dividing the total number of instructional steps performed correctly by the total number of instructional steps required. An average reliability of 97% (range = 88–100%) was maintained, suggesting consistent implementation of instructional procedures.

Data Analysis

The data were summarized in graphic form, with visual analysis of graphs used to determine the effect of instruction. Specifically, the graphs were analyzed to determine the percentage of nonoverlapping data (i.e., the percentage of data points in the intervention phase that did not overlap with any data points in the baseline phase; McReynolds & Kearns, 1983) and the slope and level of change in skills across the four phases of the study. To determine patterns of weakness, an error analysis was conducted for all incorrect probe responses. To determine the proportion of each type of error (i.e., initial, medial, or final sound), the number of each error type was divided by the total number of errors.

Data Reliability

To ensure the integrity and consistency of data recording, all instructional sessions were videotaped. Approximately 20% of sessions were randomly selected and evaluated by an individual trained in the data recording procedures. The rater evaluated accurate recording of responses during instructional tasks and probe tasks. A data reliability score was determined by dividing the number of participant responses recorded correctly by the total number of participant responses, multiplied by 100%. An average reliability of 99% (range = 90–100%) was maintained, suggesting accurate recording of response data.

Results

Single-Word Reading of Targeted Words

Following reading instruction, all 5 participants reached criterion for reading of single targeted VC and CVC words (see Figure 1 for graphs depicting the acquisition of reading skills for targeted words). Of the 5 participants, 4 demonstrated 100% nonoverlapping data between baseline and instruction, while 1, Nate, demonstrated 88% nonoverlapping data. The number of instructional sessions required by participants to achieve

criterion ranged from 10 to 34 (i.e., Dale = 10; Sam = 10; Tommy = 24; Amy = 14; Nate = 34). Dale, Sam, and Amy reached criterion relatively quickly, with instructional time ranging from 10 to 14 sessions (i.e., 5 to 7 hours). However, 2 of the participants, Tommy and Nate, received instruction for 24 and 34 sessions, respectively (i.e., 12 to 17 hours of instruction), before reaching criterion in 2 consecutive probe sessions.

An analysis of incorrect responses on probe tasks revealed that the highest percentage of errors occurred with medial sounds (range = 34–67%), the second highest with final sounds (range = 25–41%), and the lowest with initial sounds (range = 8–26%). Three of the 5 participants—Dale, Sam, and Amy—demonstrated difficulty primarily with medial vowel sounds and secondarily with final sounds. The remaining 2 participants, Tommy and Nate, demonstrated relatively equal difficulty with medial vowel sounds and final sounds.

Single-Word Reading of Novel Words

Figure 1 provides graphed data depicting the generalization of reading skills to novel words composed of targeted letters. Three of the 5 participants—Dale, Sam, and Amy—showed evidence of generalization to novel words, with performance levels for matching novel written words to pictures ranging from 60–80% accuracy. Although generalization to reading of novel words was indicated by the performance of the 3 participants, only 1, Amy, achieved criterion. These data suggest that for all 3 students who showed evidence of generalization, reading skills improved but did not reach the same level of mastery as reading for words trained in the instruction sessions. Two participants, Tommy and Nate, did not show evidence of generalization, with performance for reading novel words ranging from 20–30% accuracy.

Similar to the errors observed on probe tasks measuring reading of targeted words, the error analysis of novel words suggested that all participants had the most difficulty with medial and final sounds. For 4 out of 5 participants, the highest percentage of errors occurred with medial vowel sounds (range = 38–100%), the second highest with final sounds (range = 0–33%), and the lowest with initial sounds (range = 0–30%). One participant, Tommy, demonstrated the highest percentage of errors for final sounds, the second highest for medial vowel sounds, and the fewest for initial sounds.

Reading Performance in Book-Reading Contexts

Analysis of the data suggested that 4 of the 5 participants—Dale, Sam, Tommy, and Amy—showed evidence of skill generalization to book contexts; however,

Figure 1 (p. 1 of 2). Number of targeted and novel words read correctly by participants in reading probes.

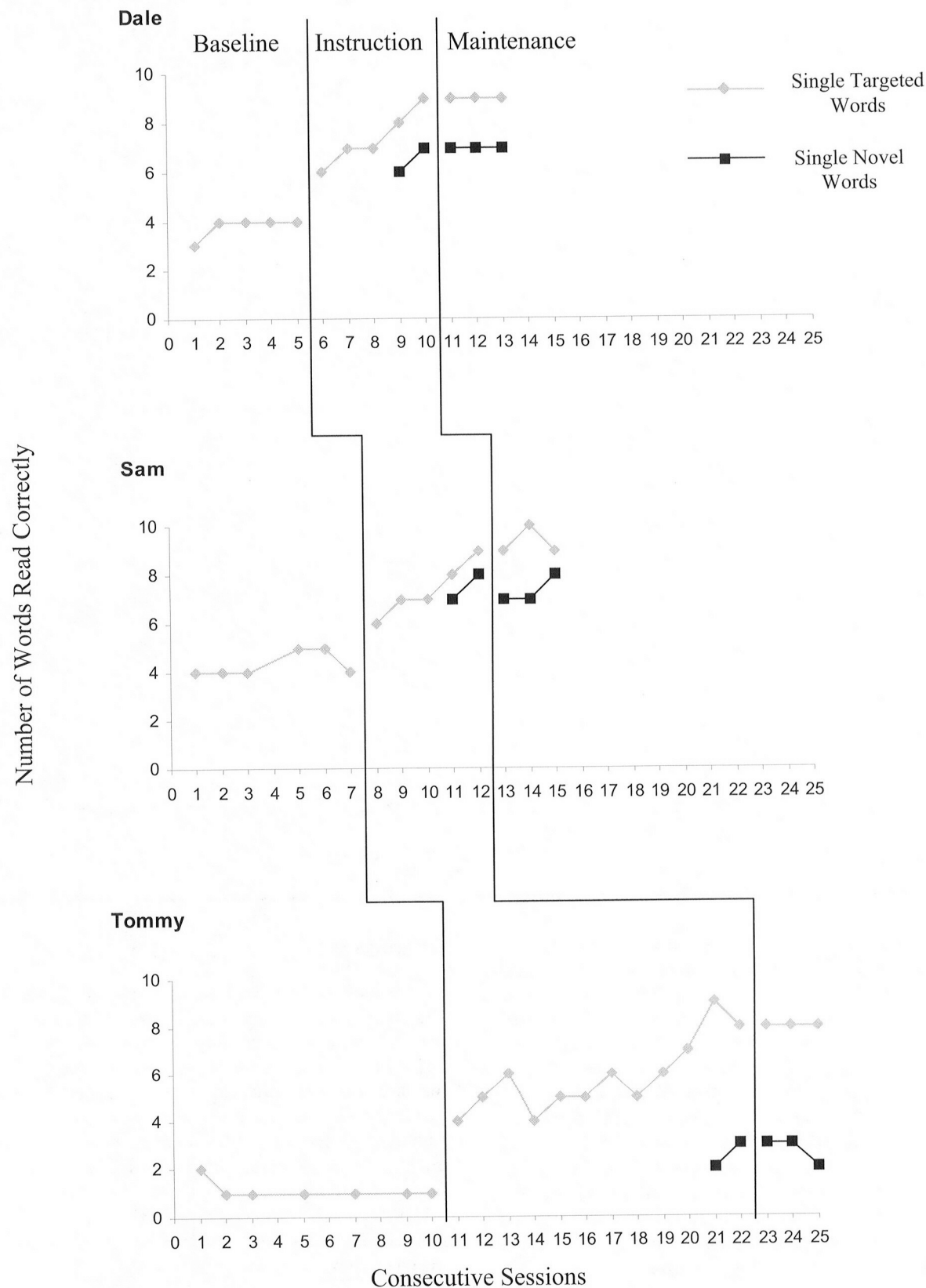
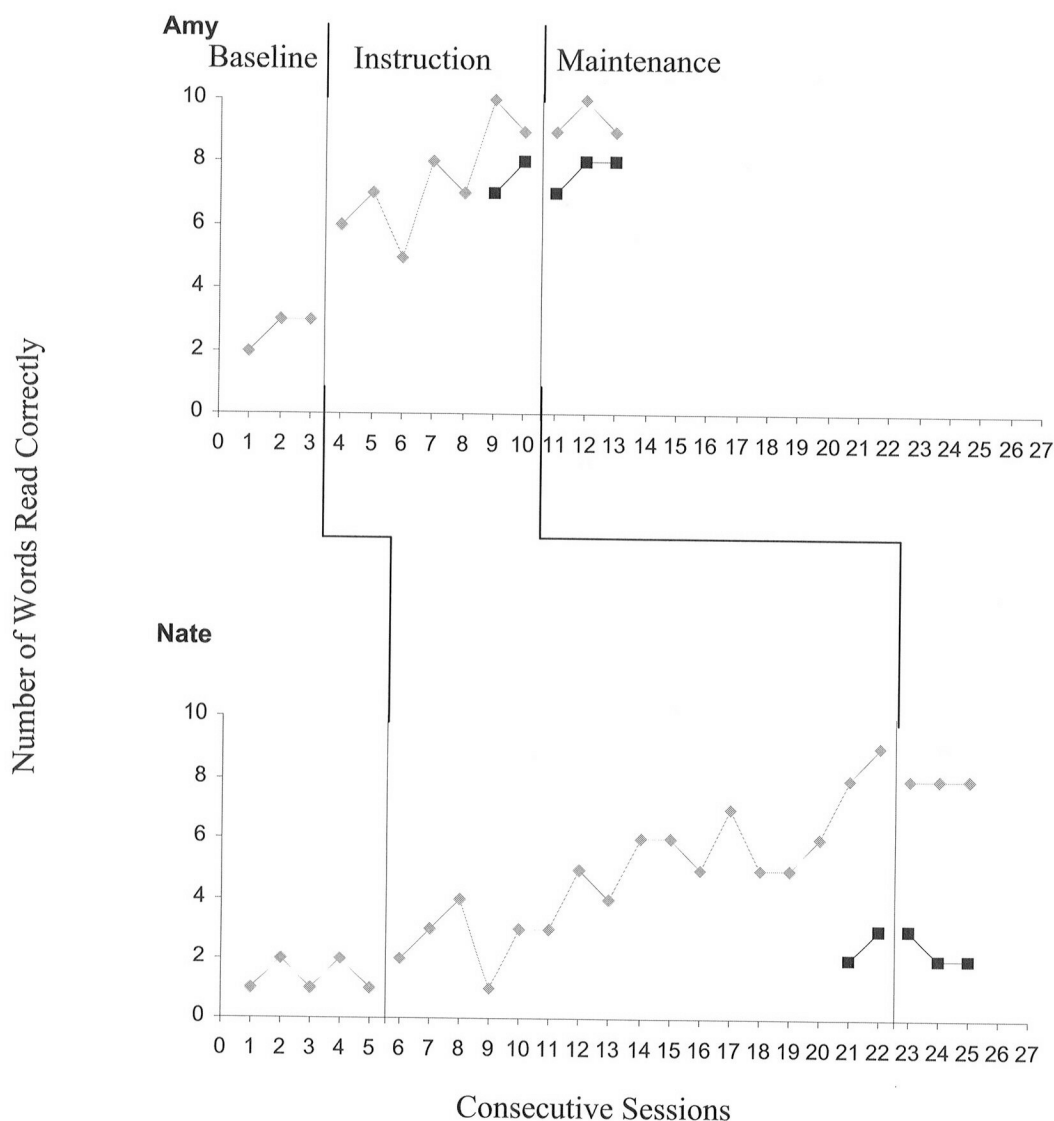


Figure 1 (p. 2 of 2). Number of targeted and novel words read correctly by participants in reading probes.



their performances in the book-reading task consistently lagged behind their reading performance on the single-word reading task (see Figure 2 for graphed data depicting the generalization of reading skills to book contexts). When these 4 participants reached criterion for reading of targeted words, scores on book-reading generalization probes ranged from 50–70%. Although generalization was demonstrated by these 4 participants, none reached the set criterion level (i.e., 80%). One participant, Nate, did not show evidence of generalization of single-word reading to contextual reading. When Nate reached criterion for reading of targeted words, he demonstrated only 30% accuracy for matching written words to the *I Spy* pictures.

Maintenance

Probes for the dependent variable and generalization measures were administered at intervals of 2 weeks, 1 month, and 2 months postinstruction. All participants demonstrated a continued ability to read at least 80% of targeted words up to 2 months after instruction. Participants who demonstrated generalization of reading skills to book contexts and novel words during the instruction phase maintained these skills for up to 2 months once instruction had ceased. Overall, skills levels observed during the instruction phase remained constant for up to 2 months post-intervention.

Figure 2 (p. 1 of 2). Number of targeted words read correctly by participants in book contexts.

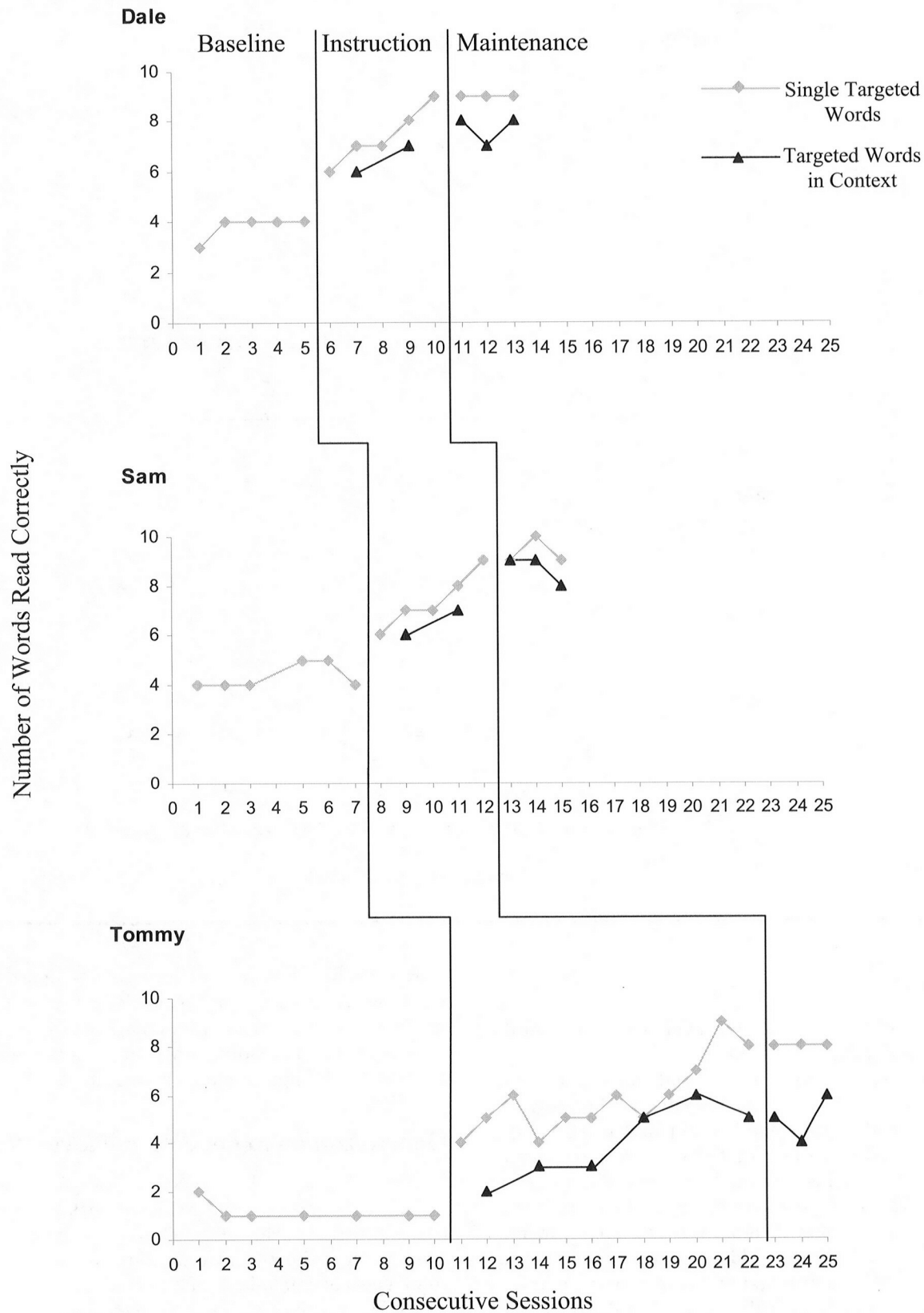
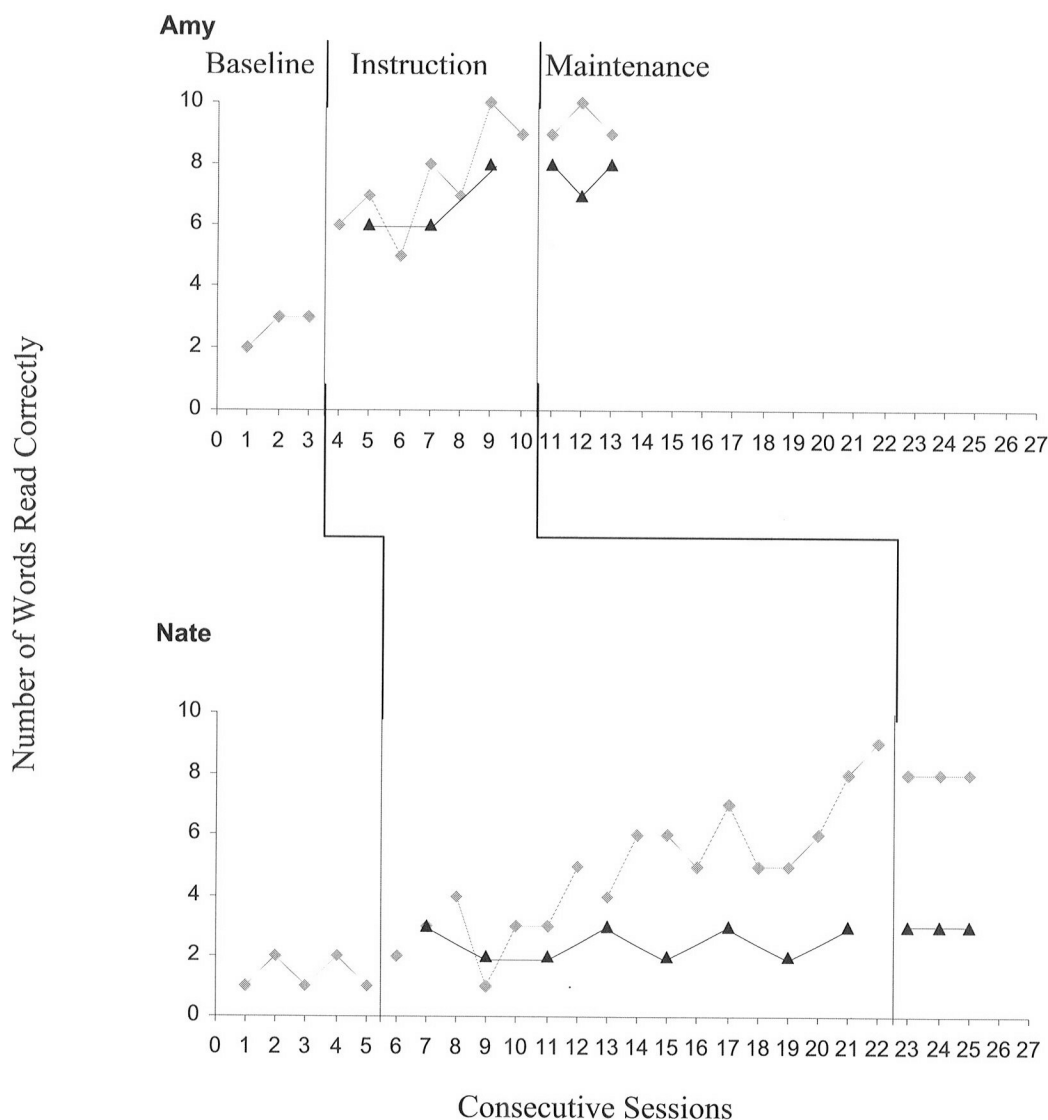


Figure 2 (p. 2 of 2). Number of targeted words read correctly by participants in book contexts.



Discussion

Results of the study provide evidence of the overall effectiveness of the reading program for improving the single-word reading skills of the 5 students who received instruction. Students who participated in the program learned to read approximately 35 to 45 words (i.e., approximately 80% of the targeted word corpus) over a range of 10 to 34 instructional sessions. The instructional program incorporated empirically validated, best instructional practices, such as actively engaging students in instructional tasks, scaffolding instructional tasks to promote errorless learning, and using a direct, explicit instructional approach (Ellis et al., 1994). Given the success of participants in learning to read targeted

words, results from the current study support the application of state-of-the-art principles of beginning reading instruction for speaking individuals to an adapted direct-instruction reading program for individuals with severe speech impairments who require AAC.

Generalization to Reading of Novel Words

The absence of baseline measures for reading of novel words and targeted words in book contexts limited definitive conclusions of skill generalization. However, as all of the novel words were randomly selected from a pool of equivalent stimuli (i.e., all depictable VC and CVC words containing targeted letters), reading performance similar to that for targeted words would

be expected for novel words. Although experimental control was not established for novel-word and book-context reading, the generalization data were gathered using a widely accepted and practiced design option in the AAC research literature (Schlosser, 2003; Schlosser & Lee, 2000) that offers valuable information concerning participant reading skills.

The novel-word probe task provided insight into the reading strategies used by the participants (i.e., sight-reading or decoding). The data suggest the use of decoding by 3 of the participants, Dale, Sam, and Amy. These students had not been instructed on the novel words probed in the generalization task, yet they were able to decode at accuracy levels well above chance (i.e., range = 60–80% accuracy).

There are data to suggest that using a code-emphasis approach to provide repeated practice in reading specific letter-sound combinations in different words will enable students to read a variety of words by blending sounds together (e.g., Carnine et al., 1997; Chall, 1996). Students are taught to decode new words rather than learning words as single units. For 3 out of 5 participants, results of the current study are consistent with these data in demonstrating the effectiveness of direct instruction to teach decoding. Results further suggest that adaptations to response formats (i.e., picture selection, rather than oral responses) may yield similar positive learning effects for students with severe congenital speech impairments.

Factors Contributing to Limited Generalization to Novel Words

For Tommy and Nate, who showed poor performance for reading novel words, the reading instruction program did not seem to strengthen decoding skills for single words. Although proficiency in reading targeted words in the single-word reading task may have resulted from the use of a decoding strategy, Tommy and Nate's lack of ability to read novel words suggests otherwise. Weak skills for reading novel words indicates that proficiency for reading targeted single words may represent improved sight-reading abilities, not gains in decoding skills. For Tommy, however, the error analysis suggested the emergence of some decoding skills for initial letters, as his errors occurred primarily in the final and medial letter positions. Conversely, Nate's errors were randomly distributed between the three sound positions, indicating that he was not decoding the first letter-sound of target words.

Although Dale, Sam, and Amy showed evidence of decoding skills, reading for novel words was not as strong as reading for targeted words. These data suggest that although participants seem to use decoding skills when reading new words, they still had not achieved mastery.

In examining the nature of the reading difficulties demonstrated by participants in the current study, research literature addressing reading skills acquisition for at-risk, reading-disabled, and severely speech-impaired individuals offers some potential explanations including: (a) weak receptive language skills; (b) weak phonological awareness skills; (c) instructional tasks that were too cognitively demanding, given the requirements for working memory; and (d) impaired speech production abilities. Although no one of these factors is thought to account entirely for the decoding weaknesses, each potentially contributed to the participants' learning patterns.

Receptive language skills. The strong connection between receptive language skills and reading achievement is well documented in the research literature, with studies consistently reporting that beginning reading success is highly dependent on vocabulary knowledge (e.g., Carnine et al., 1997; Catts & Kamhi, 1999; NICHD, 2000). Given these data, it seems important to consider the impact of weak vocabulary skills on the participants' ability to decode novel words. Carnine et al. stressed the importance of strong vocabulary skills for beginning readers by recommending daily instruction in vocabulary in addition to decoding instruction, particularly for the first words students are taught to decode.

Although it was not the primary goal of instructional tasks examined in the current study, the nature of the reading instruction program provided participants with repeated exposure to targeted vocabulary words during phonological awareness tasks (e.g., instructor labeling of the pictures during telescoping activities), scaffolding during decoding instruction, and corrective feedback. After the initial training of novel-word picture identification skills (i.e., during the vocabulary training prior to baseline), participants were only exposed to novel words if the words occurred as foils for target responses. It is possible that repeated experiences with targeted words during the instructional activities strengthened understanding of word meanings, while minimal exposure to novel words negatively affected the participants' ability to extract meaning from written words.

Phonological awareness. Overall, the participants with weaker phonological awareness profiles demonstrated poorer generalization of reading skills for targeted words to reading of novel words than students with stronger skills for manipulating sounds. These data are consistent with the solid research base describing the relationship between phonological awareness and reading achievement for speaking children (e.g., Catts & Kamhi, 1999; Smith, Simmons, & Kameenui, 1998) and, further, provide evidence of a similar relationship for individuals with congenital motor speech impairments.

Cognitive demands. The process of learning to read imposes significant cognitive demands, including

demands on working memory (e.g., Bird, Bishop, & Freeman, 1995) and the integration of multiple skills (Adams, 1990). The research literature suggests that children who are poor readers are not proficient at holding auditory information such as sounds in working memory (e.g., Liberman & Shankweiler, 1991). During decoding tasks, the need for integration of alphabetic information, phonemic information, and semantic information also presents considerable cognitive load. Weaknesses in any one of these areas can cause a breakdown in the process of decoding and acquiring meaning from print (Adams, 1990). Until beginning readers reach a level of automaticity for written word recognition, processing individual components (i.e., letters, sounds, word meaning) will require significant cognitive demands on the learner (Adams, 1990).

Speech impairment. There are empirical data to indicate that individuals who have severe speech impairments often demonstrate difficulty in acquiring reading skills (e.g., Bird et al., 1995; Foley, 1993). Individuals with severe speech impairments cannot use natural speech to receive articulatory feedback when attempting to decode written words, and therefore the acquisition of reading skills may be impeded (e.g., Foley, 1993). The speech impairments exhibited by participants may have contributed to poor generalization of reading skills to novel words.

Generalization to Book Contexts

With 4 out of 5 participants showing evidence of generalization of skills to book contexts, the results suggest the potential for students to use reading knowledge gained in structured, direct-instruction reading exercises to participate in motivating and functional reading activities. The book-reading task in the current study differed from the single-word reading task in three primary respects: (a) the target word was presented at the end of a carrier phrase rather than in isolation, (b) the response field (i.e., picture collage) offered many more than four choices, and (c) the graphic representations of response choices were different from those used in instruction and varied within the task (i.e., single-word instruction used Boardmaker line drawings of a standard size, whereas the book task involved a variety of photographs and line drawings ranging in size and position within the picture collage). Although the instructor read the carrier phrase aloud, while pointing to corresponding letters, the phrase format and increased picture choices increased the amount and complexity of visual information participants needed to process, therefore increasing task demands. Success in reading the targeted words in a storybook activity indicates that reading skills for single, targeted words were stable enough that 4 out of 5 participants could read and

extract meaning from the words in a more complex context.

Although Nate demonstrated the ability to read a few words in context (i.e., 2 to 3 words per 10-word probe), overall generalization was minimal. Nate's difficulty suggests that the single-word reading skills learned in direct-instruction sessions were not stable enough to be applied in a different context. It may be that Nate learned one paired-associate (i.e., one written word goes with a specific picture) and was not able to read the word when paired with a different picture. However, given the fact that Nate could read at least some words in the book task, it is likely that he understood the principle that a written word represents a meaningful concept and that he was not only matching written symbols to picture symbols.

Potential Program Modifications

Although all 5 participants reached criterion for single-word reading of targeted words, difficulties with generalization of skills to other reading tasks were observed. Modifications to the current instructional program may have resulted in improved outcomes for generalization of reading skills to novel words and book contexts. The following modifications may have proven useful: (a) the addition of a vocabulary instruction component, (b) modifications to the initial phoneme-matching task to reduce cognitive demands, (c) the provision of additional scaffolding during phonological awareness instruction, (d) the addition of phonological awareness tasks that target vowel sounds and final sounds, (e) increased phonological awareness instructional time, and (f) the addition of written words during phonological awareness activities.

Vocabulary instruction component. Given the vocabulary deficits noted in the participants of the current study, paired with research data suggesting the importance of vocabulary knowledge for beginning readers (e.g., NICHD, 2000; Simmons & Kameenui, 1998), the addition of vocabulary instruction may have enhanced reading outcomes. Although the ability of participants to identify target vocabulary words was ensured prior to beginning the reading program, further vocabulary instruction using a variety of graphic representations may have been beneficial. Ongoing vocabulary instruction that incorporated more than one picture representation (e.g., as in the picture collage task) may have strengthened understanding of word meanings, as well as introduced vocabulary to be used in future decoding training.

Phonological awareness task modifications. First, given the difficulty demonstrated by 2 participants on the initial phoneme-matching task, modifications to

reduce the working memory demands of the task seem warranted. Presenting the target sound before each of the four word choices may have reduced the cognitive load (e.g., /p/-men, /p/-pen, /p/-bib, /p/-nap). In addition, further scaffolding might have been beneficial. For example, during the initial phoneme-matching task, the instructor could have first presented the word choices with the initial sound segmented (e.g., /m/-men) then presented the words without the first sound segmented. By adding fading external supports and additional trials, performance may have improved.

Evidence from the decoding error analysis indicates that vowel sounds and final consonant sounds were areas of weakness for participants. The inclusion of additional phonological awareness tasks to target medial vowel sounds and final sounds might also have been useful. It is possible that additional phonological awareness training (e.g., trials with scaffolding support) may have increased the generalization of reading skills to book contexts and novel, single-word reading.

Finally, current research suggests that phonemic awareness instruction is more effective when children are taught to use the letters of the alphabet to perform sound manipulation tasks (NICHD, 2000). It may have been helpful if the phonemic awareness activities included a phonics component that provided a means for the participants to use the letters to perform blending and phoneme-matching tasks.

Limitations of the Study

The current study's investigation of the effects of direct instruction on the reading skills of children with severe speech impairments offers important data; however, the study does have some limitations. First, the study included a relatively small number of participants. With only 5 students participating in the reading instruction program, generalization of results must be considered carefully. Optimally, replication of the study would strengthen the external validity of results.

There were also limitations to the instructional program. Instructional sessions were delivered consistently two to three times per week; however, for beginning readers, daily instruction is recommended (e.g., Carnine et al., 1997). Results of the study may have been strengthened had instruction been delivered every day, rather than only a few times a week. Also, the sequence of skills taught in the instructional program may not have been optimal. The research emphasizes the benefits of teaching phonological awareness skills before beginning reading instruction (e.g., Carnine et al., 1997). Had phonological awareness skills been more firmly in place, greater generalization to novel words (i.e., decoding skills rather than sight-reading skills) may have occurred.

Finally, given the nature of the tasks, it was difficult to determine whether students were sight-reading or actually sounding out words. With the inclusion of novel words, some evidence to answer this question was provided. However, without the benefit of spoken responses, determining the cognitive and linguistic processes performed by participants was difficult. In addition, baseline data were collected only for targeted words, not for targeted words in book contexts and reading novel words. Therefore, it is not possible to determine changes in these skills as a result of the instructional program.

Future Research Directions

Results of the current study suggest several potential directions for future research in the area of literacy and AAC. First, in order to increase the generalizability of results, it is important to replicate the study implementing the suggested program modifications with additional students who have congenital speech impairments. Investigating the response of additional individuals who have congenital speech impairments would lend strength to the findings of the current study and help determine the validity of suggested program modifications. It is important to adapt reading programs according to the specific needs of each population (e.g., appropriate words and picture representations for adults). In addition, it is important to develop reading instruction programs that promote the development of decoding skills in addition to sight-reading skills in students who require AAC. One potential avenue to explore might be the modification of standard reading curricula to meet the unique needs of students who require AAC.

It is also important to investigate the effects of a classroom-based, direct-instruction program to teach beginning reading to children who require AAC. Specifically, it would be interesting to study the response of students who require AAC to small-group reading instruction, rather than one-to-one instruction, as well as the overall effectiveness of an adapted program in a classroom setting.

The current study looked specifically at beginning reading instruction. Further studies are necessary to investigate best practices to guide reading instruction for individuals at later stages of reading development, including reading fluency and automaticity, accessing meaning from text, and reading comprehension for extended text.

Finally, given the documentation of the relationship between speech production abilities and reading acquisition, the impact of auditory feedback on learning to read should be investigated. Studies to investigate natural articulatory feedback and the potential benefits of synthesized speech feedback may be beneficial.

Conclusions

The current study contributes important preliminary information concerning the effects of reading instruction for individuals with severe congenital speech impairments. Results of the study suggest the effectiveness of explicit, direct instruction to teach reading skills to individuals with severe speech impairments. Generalization of reading skills to novel words suggests the ability of some students to acquire decoding skills, while generalization to book contexts suggests the ability of students to apply single-word reading skills to functional reading situations. Overall, results of the study provide evidence that children with congenital speech impairments can acquire beginning, single-word reading skills through a direct-instruction reading program. The results further provide preliminary data to guide teachers and AAC professionals in the instruction of individuals who use AAC. With the appropriate instruction to support the development of reading skills, children who require AAC will be better prepared to successfully participate in academic, vocational, and community activities.

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Contact author: Karen A. Fallon, Indiana University of Pennsylvania, Department of Special Education and Clinical Services, 203 Davis Hall, Indiana, PA 15705-1087. E-mail: kfallon@iup.edu

Appendix. Stimulus lists.

Targeted words				
bag	in	Miss	pet	sip
bat	leg	mom	pig	sit
beg	lip	mop	pill	sun
bell	lit	mug	pop	tag
bib	log	nap	pot	tan
bug	map	net	ran	tap
bus	mat	not	rat	ten
egg	men	pal	rim	toss
gas	mess	pan	rip	tub
gum	met	pen	rug	up
Novel words				
big	lap	pass	rib	set
bit	less	pat	rob	tip
bun	man	pin	run	top
gun	nut	pup	sat	tug
ill	on	rag	sell	us