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The Effect of Direct Instruction and Writer's Workshop on the Early Writing Skills of Children Who Use Augmentative and Alternative Communication

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A single subject multiple probe across subjects research design was used to evaluate a writing instructional program for children who use augmentative and alternative communication (AAC). Specifically, the effect of instruction on the selection of initial letters of words by 3 children with developmental disabilities who used AAC was evaluated. The writing instructional program comprised direct instruction in letter-sound correspondence and selection of initial letters of words, and a writing workshop-type task to provide instruction in literacy activities. Two of the 3 children were successful in the acquisition of the target skill, maintained use of the skill at least 1 month following instruction, and demonstrated some generalization of the skill to less structured tasks. The third child required a simplified instructional program to accommodate transient episodes of hemiplegia and to increase his time on task. The results of the study suggest that an instructional program that combines a direct instruction approach and a writing workshop-type activity may facilitate the development and application of phonemic awareness skills with children who use AAC.

Keywords: Augmentative and alternative communication; Children; Literacy; Writing; Phonemic awareness; Letter-sound correspondence

The development of literacy skills is of critical importance to individuals who require the use of augmentative and alternative communication (AAC). Individuals who use aided AAC systems, such as communication boards or computer-based voice output systems, require vocabulary represented by tangible symbols (e.g., real objects, miniature objects, partial objects), representational symbols (e.g., photographs, line drawings), or orthographic symbols (e.g., letters, words, sentences; Beukelman & Mirenda, 1998). One of the benefits of having functional literacy skills is that an individual who has access to an AAC system with an alphabet display can spontaneously generate vocabulary during conversations. In addition to enhancing the communication of individuals who use AAC, functional literacy skills are critical for the development of self-expression, independence from caregivers and aides, links to written information (e.g., Internet use, personal correspondence, literature), recreational opportunities, educational opportunities, employment opportunities, and overall participation in a highly literate society (e.g., Kelford Smith, Thurston, Light, Parnes, & O'Keefe, 1989; Light & McNaughton, 1993). Individuals who lack functional literacy skills are unable to use vocabulary represented orthographically, and therefore must rely on tangible or representational symbols. This severely restricts generative capacity during communicative interactions because the individual who uses AAC must rely on a partner to predict necessary vocabulary and to provide appropriate symbol representations prior to communicative interactions.

Research has suggested that children with significant physical and communication disabilities who use AAC are at risk of difficulties in the development of functional literacy skills (Kelford Smith et al., 1989; Koppenhaver & Yoder, 1993). Approximately 70 to 90% of individuals who use

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AAC demonstrate low levels of performance in literacy learning activities (Koppenhaver, Steelman, Pierce, Yoder, & Staples, 1993). In part, individuals who use AAC may have difficulty acquiring functional literacy skills because they receive quantitatively and qualitatively less literacy instruction than their nondisabled peers (e.g., Koppenhaver & Yoder, 1992). Unlike the development of spoken language, formal instruction is required for the acquisition of written language (e.g., Adams, 1990).

Within literacy, writing remains the most neglected aspect of instruction, research, and experience in the lives of individuals who use AAC (Foley, 1993; Glennen & DeCoste, 1997; Koppenhaver & Yoder, 1992). Research has shown that more instructional time is spent on reading than on writing with children with disabilities (e.g., Koppenhaver & Yoder, 1992). Writing instruction may be emphasized less because it is considered to be more difficult than reading; there are additional memory demands required in encoding sequences of individual letters and words compared to decoding a static sequence (Ehri, 2000). The slower rate of creating written text by individuals with severe physical impairments further increases memory demands. The deficiency in writing instruction may also be evident because writing is a time consuming and frustrating process for individuals who use AAC in the early stages of development of literacy skills.

There is a critical need for research to evaluate the efficacy of instructional approaches to teach writing skills to children who use AAC (Foley, 1993; Glennen & DeCoste, 1997). In fact, at present, there are no evidence-based writing instructional programs available to guide teachers in the development of instructional activities that have been appropriately modified for individuals who use AAC. The existing writing instructional programs for school-aged children without disabilities rely heavily on both the teacher's and children's speech productions (e.g., Adams, 1990). Therefore, children with significant speech impairments have considerable difficulty participating in meaningful ways and are at serious risk for difficulties in developing phonemic awareness and letter-sound correspondence skills by following the existing instructional programs (Foley, 1993). Appropriate adaptations are necessary to facilitate the participation of children with disabilities in literacy instructional programs.

In the absence of appropriate writing instruction, the general principles identified as best practices for children without disabilities may be used as a guide, with special adaptations to accommodate the unique needs of children who use AAC (e.g., McNaughton & Tawney, 1992). Important considerations in designing a writing instructional program targeting early literacy skills are: (a) content of the program, (b) instructional techniques, and (c) required adaptations to accommodate motor and speech impairments.

INSTRUCTIONAL CONTENT

Research with individuals without disabilities has demonstrated that the best predictor of success in literacy development is phonological awareness (e.g., Ehri, 2000; Liberman, Rubin, Duques, & Carlisle, 1985; Nation & Hulme, 1997). Phonological awareness is the ability to discriminate and manipulate individual phonemes or word segments (e.g., syllables, onsets, and rimes) of spoken language (Blachman, 1989). Phonemic awareness refers more specifically to the knowledge that spoken words may be divided into sound segments (Ball & Blachman, 1991; Mann, 1986). Phonemic awareness has been identified as one of the most important factors influencing improvement in children's development of spelling (e.g., Ehri, 2000; Liberman et al., 1985). It is generally accepted that regardless of the approach to writing instruction, a program should include a component that targets instruction in phonemic awareness (e.g., Ehri, 2000; Spector, 1995; Traweek & Berninger, 1997) and letter-sound correspondence (e.g., Blachman, 1989; Ball & Blachman, 1991).

Segmentation is the identification of a single sound of a word, and it has been shown to be a predictor of the development of reading and spelling; moreover, the assessment of segmentation skills is often used as an indication of emerging spelling skills (Masterson & Apel, 2000; Nation & Hulme, 1997). The earliest developing form of phonemic awareness is the segmentation of the onset of one-syllable words, or the first sound in a word (Vandervelden & Siegel, 1995). Later developing phonemic awareness skills include segmentation of all individual sounds in a word, or the manipulation of specific sounds in words (e.g., deletion of sounds, substitution of sounds; Blachman, 1989, 1991; Nation & Hulme, 1997; Vandervelden & Siegel, 1995, 1999). Letter-sound correspondence refers to the knowledge that phonemes are represented by alphabetic orthography. A number of studies have compared instruction in phonemic awareness alone, letter-sound correspondence alone, and phonemic awareness with letter-sound correspondence. Results have demonstrated that the combination of phonemic awareness and letter-

sound instruction facilitates the most success in beginning reading and writing (e.g., Ball & Blachman, 1991; Blachman, 1989; Bradley & Bryant 1983, 1985; Cunningham, 1995; McGuinness, McGuinness, & Donohue, 1995).

In summary, according to research with children without disabilities, the skills critical for the development of an early writing instructional program are segmentation of the initial sound of words and letter-sound correspondence. It seems reasonable to argue that these skills are also important for individuals who require AAC.

INSTRUCTIONAL APPROACH

In current research, the value of both explicit instruction and authentic writing experiences as approaches to instruction in writing have been recognized (e.g., Scott, 2000; Spiegel, 1992). The following discussion provides a description of the two approaches to instruction and suggests a method for integrating the most advantageous components of them into a single instructional program.

In general, the primary goal of direct instruction in writing is that children master the basic skills so that they can focus on the construction of the content of their writing (e.g., Kameenui, Simmons, Chard, & Dickson, 1997; Graham & Harris, 1994). The principles of direct instruction include (a) explicit and systematic instruction (i.e., the lessons are structured and the targeted skills are taught in a methodical order); (b) instruction in small groups; (c) frequent opportunities to practice the targeted skills; (d) teacher-directed learning; and (e) minimal practice of errors (e.g., model-prompt-check format of instruction; Simmons & Kameenui, 1998; Spiegel, 1992). This method of instruction allows the provision of multiple practice opportunities and simultaneously minimizes the practicing of errors by the child.

In writing workshops, there is an emphasis on the content of the children's writing rather than correct spelling (Gentry & Gillet, 1993; Calkins, 1994; Graves, 1983, 1994). For young children beginning a writing workshop, expression of ideas, not correct spelling, is the primary goal of the writing activities (Calkins, 1994; Graves, 1983, 1994). The use of writer's workshops is based on a number of principles, including the beliefs that: (a) there is a great deal of information about learning to read and write that is best acquired through use in naturally occurring contexts; (b) learning should be child-centered; (c) teachers serve as facilitators for children's learning and are expected to recognize teachable moments and provide personalized, individual instruction in specific writing skills via conferences, mini-lessons, modeling, and unscripted dialogue; (d) learning should address content and process, not just form; (e) children are provided with lengthy and frequent opportunities to write; (f) children should be encouraged to take ownership and responsibility for their learning (e.g., choosing their own books to read and choosing the topics of their stories); and (g) children should share their work with their peers (e.g., conferencing with peers; Graham & Harris, 1994). A writing workshop provides children with authentic writing experiences they can use to learn to write (e.g., Atwell, 1987; Graves, 1983, 1994).

There are advantages and disadvantages to both direct instruction and writer's workshop approaches to writing instruction. A combination of the two approaches, to integrate the strengths of each, may be the most effective method of writing instruction (e.g., Graham & Harris, 1994; Spiegel, 1992). The integrated approach to instruction should include (a) explicit, structured instruction in the skills necessary for developing writing (e.g., letter-sound correspondence, phonemic awareness); (b) numerous opportunities for children to actively participate and practice the specific skills; and (c) extended and frequent opportunities to apply the specific skills in writing experiences.

ADAPTATIONS

In addition to the content and instructional methods of a writing program, unique adaptations for children who use AAC must be considered. The current writing curricula rely on oral productions by the teacher and the children. Children with significant speech impairments are not able to participate without providing specific adaptations that allow them to participate without using speech. In letter-sound correspondence activities, for example, the teacher may produce a sound and ask the child to identify the letter that corresponds with that sound using a communication system with the alphabet represented on the system. Additional scaffolding supports may also be necessary for children with significant speech impairments: For example, during tasks that require the children to select the initial letter of a word, the instructor may provide the oral model of the word before the children select the initial letter. Hearing the spoken word first may facilitate the children's segmentation of the initial phoneme and selection of initial letters. Special adaptations may also be necessary for children with motor impairments. During writing tasks,

children unable to write with a pencil may be provided with a communication system that has an overlay of the alphabet. Specific adaptations may vary, depending on the nature of children's motor and speech skills. It is critical, however, to consider the adaptations necessary to provide children who use AAC with a means to participate in writing instruction.

In light of the need for intervention studies to evaluate methods of adapting writing instruction for children who use AAC, the objective of the present study was to determine the effect of a writing instructional program on the selection of initial letters of words by children who used AAC, a first step in the writing process.

METHOD

Research Design

A single subject multiple probe across subjects experimental research design was used involving 3 children who used AAC. The independent variable was the writing instructional program, a package that included direct instruction in 2 skills (i.e., letter-sound correspondence, and phoneme segmentation and selection of initial letter) and a writing workshop-type activity that provided instruction within meaningful writing tasks. The dependent variable was the selection of the initial letter when orally presented with single words in a dictation task.

Participants

Three children who used AAC were invited to participate in the writing instructional program. All participants met the following selection criteria: They (a) were between the ages of 6 and 12; (b) had a developmental disability (e.g., cerebral palsy); (c) had hearing and vision (with or without correction) within normal limits, as reported by parent, teacher, and/or therapist; (d) had a significant speech impairment (i.e., less than 50% intelligible to an unfamiliar partner, as documented by the transcription of a recorded speech sample by an unfamiliar partner); (e) required the use of an AAC system (i.e., unable to meet daily communication needs through natural speech alone); (f) had adequate language skills to follow simple directions necessary for participating in the instructional program, as measured through a screening of the instructions of the program and formal measures of receptive language, the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981) and the Test for Auditory Comprehension of Language-Revised (TACL-R; Carrow-Wolfolk, 1985); (g) had literacy skills at the partial alphabetic level (i.e., able to correctly identify at least 70% of the letters of the alphabet from a field of four when orally presented with the corresponding letter name, may be able to read words by memorizing or guessing from context cues, but unable to decode unfamiliar words; Ehri, 2000); (h) had writing skills at the earliest stage of development (i.e., lacked phonemic awareness skills related to segmenting initial, final, or medial letters of single words, as measured in an initial screening); and (i) had consent from parents or guardians to participate in the project.

Children were recruited by contacting local speech-language pathologists and teachers of special education classes. The speech-language pathologists and teachers were provided with a description of the project and passed information on to the families of potential participants. Once consent was provided by the potential participants, they were then screened by the investigator to determine their eligibility to participate. See Table 1 for a summary of the key demographic information for the participants (Melinda, Haley, and Gary).

Melinda

At the time of the study, Melinda was a 7 year old girl diagnosed with spastic quadriplegic cerebral palsy and cystic fibrosis. She had a congenital amputation of her left hand, had very little voluntary motor control, and demonstrated poor postural control. She used a wheelchair for mobility. Her hearing and vision (with glasses) were reported to be within normal limits by her mother. Melinda lived at home with her older sister, mother, and father. She had a full-time personal care aide during school.

Melinda was mainstreamed in a first grade class; however, she participated in a modified curriculum. Her literacy instruction in school focused on developing word recognition skills. Each week, Melinda was provided with a short list of words to memorize. At the end of the week, she was asked to identify the words written on index cards, in a dictation task using eyegaze. Melinda's personal care aide was the primary person providing literacy instruction in the classroom. She reported that Melinda had difficulty with the task and that she did not think Melinda was successful much beyond chance level in the weekly activities.

Melinda communicated via occasional vocalization, eye pointing, and gestures for yes/no (i.e., a shoulder shrug for yes and a head shake for no), and a voice output communication aid (VOCA) (a DeltaTalker^{TM})[1] that he accessed via scanning,

TABLE 1 Demographic information for participants

	Melinda	Haley	Gary
Age	7 years	10 years	10 years
Diagnosis	Cerebral palsy, Cystic fibrosis	Cerebral palsy	Alternating hemiplegia
Means of communication	Gestures, eye pointing, DeltaTalker via scanning	Gestures, pointing, speech approximations, communication boards, Dynavox via scanning	Gestures, pointing, speech approximations, DynaMyte via direct selection
Speech intelligibility	Occasionally vocalizes	30%	0%
	Language skills (standard score)		
PPVT	77	51	40
TACL-R	77	65	65
	Literacy skills		
Letter names	88%	96%	70%
Initial letter selection	6%	10%	0%

and which was operated by a small switch mounted near her chin. The DeltaTalker^{TM} had an overlay with eight symbols (photographs and line drawings) that included the people in her family (e.g., *MOM*) and phrases (e.g., *MY TURN*) for use during games. Melinda's communication was generally limited to answers to yes/no questions, communication of choices, and requests for objects or actions.

Melinda achieved a raw score of 75 on the PPVT-R (Dunn & Dunn, 1981). She had a raw score of 83 on the TACL-R (Carrow-Wolfolk, 1985). Prior to instruction, Melinda had an accuracy of 88% when asked to identify a letter from a group of 4 when provided with the name orally. She had an accuracy of 6% when asked to identify the first letter of a word from a field of 4 when presented with the word orally.

Haley

At the time of the study, Haley was a 10 year old girl with spastic cerebral palsy. She used a wheelchair and a walker for mobility. Haley lived at home with her 4 sisters and parents. She was in a special education class for most of her school day, with approximately 5 other children with physical and speech impairments. She was included in a second grade class for one class, social studies, each day. Literacy instruction at school focused on letter-sound correspondence. Haley practiced identifying letters when provided with the corresponding sounds; her special education teacher also encouraged her to attempt the productions of sounds when provided with the corresponding written letter.

Haley used a combination of speech approximations, gestures (e.g., pointing, head nod and shake for yes/no), and communication boards to communicate. At the time of the study, she was being introduced to a voice output communication aid (i.e., a DynaVox^{TM})[2] via scanning, controlled by a switch activated by short breaths of air. Haley preferred to use speech approximations to communicate and only infrequently used aided AAC systems. The intelligibility of her speech was 30%, as judged by an unfamiliar partner. The vocabulary of her communication boards (approximately 20 words per board) used in school was organized schematically (e.g., a page about the calendar, a page for cooking activities) and represented with line drawings. Haley participated in conversations by taking both obligatory turns (e.g., answers to questions) and optional turns (e.g., turns following a partner's comment). Her utterances were usually about 3 to 4 words in length and typically were simple agent-action-object structures (e.g., *I want game*).

Haley had a raw score of 61 on the PPVT-R (Dunn & Dunn, 1981). She achieved a raw score of 50 on the TACL-R (Carrow-Wolfolk, 1985). Prior to instruction, she was able to identify a letter when provided with the name orally with 96% accuracy. She had an accuracy of 10% when asked to identify the first letter of a word from a field of four when presented with the word orally.

Gary

Gary was a 10 year old boy with alternating hemiplegia of childhood, a rare neurological disorder characterized by repeated, transient attacks that may affect either side of the body (National Organization for Rare Disorders, 1996). Gary required the use of a wheelchair for mobility. He lived at home with his younger brother and parents. He was in a special education class at school and attended a daycare program with nondisabled children after school. Literacy instruction at school focused on letter-sound correspondence only.

Gary primarily used vocalizations, some speech approximations, and gestures; and a VOCA (i.e., a DynaMyte™)[3] that he accessed via direct selection with his finger. Gary preferred to use vocalizations and speech approximations to communicate and used aided AAC systems infrequently. The intelligibility of his speech to unfamiliar partners was 0%. He had approximately four pages of vocabulary in his DynaMyte™ with approximately 10 concepts per page (e.g., people in his family, needs and wants for school, some phrases for comments). Gary's vocabulary was represented by line drawings and organized schematically. Gary typically fulfilled obligatory turns (e.g., answers to questions) and some nonobligatory turns (e.g., requests, simple comments).

Gary had a raw score of 4 on the PPVT-R (Dunn & Dunn, 1981). He achieved a raw score of 7 on the TACL-R (Carrow-Wolfolk, 1985). Prior to instruction, Gary had an accuracy of 70% when asked to identify a letter when provided with the name orally. He had an accuracy of 0% when asked to identify the first letter of a word from a field of four when presented with the word orally.

Materials

The study involved 3 types of materials: an adaptive keyboard, screening materials, and instructional materials.

Adaptive Keyboard

An adaptive keyboard, the DiscoverBoard™ [4], was used with a laptop computer with a Macintosh operating system and Discover: Create ™ [5] software for the writing instructional program. The keyboard displayed the letters of the alphabet, including short and long vowels, for a total of 31 letters arranged in alphabetical order. The long vowels were represented with a horizontal line above the letter in order to distinguish them from the short vowels. The letters were lower-case and approximately one inch high. Five letters were targeted for instruction: These target letters (i.e., s, d, c, f, b) were highlighted in yellow throughout baseline, instruction, maintenance, and generalization. When the keys were depressed, a digitized recording of the corresponding sound (not the letter name) was produced to reinforce letter-sound correspondence throughout the instructional program. Access to the system was customized to suit the motor skills of each participant. Gary used direct selection (with his finger) to access the keyboard. Partner-assisted scanning of the entire array of 31 letters was used with Melinda and Haley because they were not able to direct select.

Screening Materials

Five target letters were identified for instruction by screening the children's abilities to select initial letters of single words in the following manner. First, a pool of words with each of the letters of the alphabet in the initial word position was created using dictionaries and children's books. Next, the instructor orally presented each word and asked participants to identify the initial letter using the adaptive keyboard. The letters that were not identified correctly by any of the participants were considered potential target letters. Finally, 5 of the potential target letters that occurred early in the sequence of letters for instruction recommended by DISTAR (Engelmann & Bruner, 1978) were selected. The 5 letters targeted for instruction were s, d, c, f, and b.

Instructional Materials

Materials for the instructional program and assessment probes were developed using a large pool of words that began with the target letters. The criteria for inclusion of a word was that it (a) could not be more than 2 syllables in length, (b) had to be able to be represented by a picture, and (c) had to be a word known to all participants. Children's books and dictionaries were used to generate the pool of words. Approximately 4 in color pictures representing the words were obtained from Boardmaker™ [6] and CorelDRAW™.[7] Using a receptive language task, the words were screened with all three participants to determine which words were within their vocabulary. Words that were correctly identified by all three participants were included in the corpus of words for instructional stimuli and probes; words that were not correctly identified by all 3 participants were excluded from the pool.

There were three types of words developed for the study: instructional stimuli, instructional probes, and generalization probes. The instructional stimuli consisted of 12 words per target letter. The stimuli were used to teach the target skills during the instructional phase of the study. The instructional probes consisted of 25 items, 5 words for each target letter. Each word did not appear more than once within a single probe, and was used 8 or 9 times across the set of 28 probes. The probes were used during baseline, instruction, and maintenance to document progress in the acquisition of selection of initial letters of words. The order of the probes during baseline,

instruction, and maintenance was randomized across participants. Each of the generalization probes consisted of 25 items, 5 words per target letter. None of the words had been used in previous phases of the study to document generalization of the target skill to novel words.

Measures

The dependent variable, selection of initial letters of words presented orally in a dictation task, was measured during baseline, instruction, maintenance, and generalization. The probes consisted of 25 randomized trials, 5 per target letter. Participants selected letters using the adaptive keyboard.

Collateral data for letter-sound correspondence and selection of initial letters of words in a writing workshop-type task were also collected, along with the probes for the dependent variable. The probe to measure letter-sound correspondence consisted of 25 trials, 5 trials for each target letter, presented in random order. Participants were presented with a sound orally and asked to identify the corresponding letter from a field of four. During the writing workshop-type task, participants were asked to use the adaptive keyboard to write about 5 pictures, each of which represented a word with a target letter in the initial position. Data were scored only for the selection of initial letters.

Reliability of the Measures

Inter-rater reliability was calculated for approximately 30% of the data randomly sampled from each of the probes in baseline, instruction, maintenance, and generalization. A second researcher viewed videotapes of the administration of the probes and recoded the data; the responses were coded as correct, incorrect, or no response. The inter-rater reliability was calculated as a percentage of the number of agreements divided by the total number of agreements and disagreements. The inter-rater reliability was 96% (range 88 – 100%) for selection of initial letter, 96% (range 88 – 100%) for letter-sound correspondence, and 100% for the selection of initial letter in a writing task, across the participants.

Procedures

The study involved four phases: baseline, instruction, maintenance, and generalization. Participants were pulled out of their classrooms for all sessions and worked individually with the primary researcher in a quiet room without distractions.

Baseline

During each baseline session, a 25-item probe for the dependent variable was administered. Participants were asked to use the adaptive keyboard to select the initial letter of a word presented orally in a structured dictation task. A minimum of 3 measures of the dependent variable was collected with each participant prior to instruction, in order to establish a stable baseline (i.e., a minimum of 3 points with a slope at or near 0). Instruction was introduced to the first participant while the other 2 participants remained in baseline, in order to establish experimental control. Once treatment effects were observed for the first participant, instruction was implemented with the second participant; the third participant remained in baseline to maintain experimental control. Once treatment effects were observed with the second participant, instruction was introduced to the third participant. Treatment effects were defined as the acquisition of selection of the first letter of a word, for two of the letters targeted for instruction. Acquisition of selection of a letter was defined by a criterion of 80% correct (i.e., at least 4 out of 5 trials correct for the target letter) over two consecutive probes.

Instruction

Instruction consisted of approximately 2 or 3, 30 – 45-min sessions per week. Each instructional session focused on one target letter, with a review of previously acquired letters. Instruction started with an introduction to the target letter and a brief description of the tasks.

There were three instructional activities: (a) letter-sound correspondence, (b) selection of initial letter, and (c) writing workshop-type activity. Each activity was presented as a card game in which participants accumulated cards for correct responses. Knowledge of letter-sound correspondence is required for the acquisition of selection of initial letter; therefore, letter-sound correspondence was included as part of the instructional activities. In the letter-sound correspondence task, the instructor orally presented the sound of the target letter and the participant was asked to select the corresponding letter from an array of 31 letters using the adaptive keyboard.

In the selection of initial letter task, the participant was asked to select the initial letter of a word using the adaptive keyboard; the words were presented orally by the instructor in a dictation task. A most-to-least prompting hierarchy was used to facilitate errorless learning (Kameenui et al., 1997). The hierarchy consisted

of 3 levels: full, partial, and no prompt. For the full prompt, the instructor elongated and stressed the first sound. A pause was also added between the first sound and the rest of the word. For a partial prompt, the instructor elongated and stressed the first sound without inserting a pause after the first sound. The instructor did not elongate or stress the first sound for the no prompt level.

The final activity was a modified writing workshop-type activity. There were three major challenges in designing a writing workshop-type activity for the participants. First, it was necessary to limit the scope of the stories so that the invented spellings for target words could be identified easily by the instructor. Second, it was also critical to incorporate the target letters into the words attempted in the initial position to measure the participants' generalization of the acquired skills to writing tasks. Third, it was important to allow the participants some flexibility in writing their own stories. The result was that the participants were provided with multiple options of single words for each picture in the stories. The participant was asked to write a story about himself or herself using a sequence of four pictures as a visual prompt; the participant was given 1 picture of himself or herself, and 3 pictures representing vocabulary that began with the target letter of the session (e.g., sofa, sunny, sad). For each picture, the instructor orally presented the participant with choices of words for the participant to choose (e.g., sofa, sit, seat) that could be used to write a story. The pictures represented vocabulary that began with the target letter in order to provide opportunities for the child to use the skill of selection of initial letter in writing tasks. Following the completion of the participant's story, the instructor modeled the selection of initial letters and modeled an elaborated story linking the words the participant wrote for each picture; no prompts were provided while the participant was selecting letters for the story.

Probes were administered after each set of two instructional sessions to document the participants' progress and to determine when to introduce the next target letter. If the participant again reached the criterion accuracy for the target letter (i.e., 4 out of 5 items correct for the target letter), a second probe was administered in the next session. If the participant reached the criterion accuracy for the target letter, instruction for the next target letter was initiated in the next session. If the participant did not reach the criterion accuracy, for the first or second probe, instruction in the target letter was repeated for the next two sessions.

Maintenance

Once all 5 of the target letters were acquired with an accuracy of 80% on the probes for the dependent measure for 2 consecutive sessions, instruction was completed and the final maintenance phase was initiated. During maintenance, no instruction was introduced. Probes were administered 3 days, 1 week, 2 weeks, and 1 month following instruction.

Generalization

Two generalization probes were administered the first and second day after instruction was completed. The generalization probes assessed the ability of the participants to segment and select the target letters in the initial positions of novel words when they were shown a picture, but without the instructor orally presenting the word.

Procedural Reliability

A standard for the procedures was developed and the instructor and a second researcher were trained until they reached at least 90% accurate with the standard. The standard included procedures for partner-assisted scanning for Melinda and Haley. Procedural reliability was determined for a random sample of 30% of the instructional sessions to ensure the integrity of the procedures. The trained researcher viewed videotapes of the sessions and coded whether the instructor followed the correct procedures for each step according to the standard. Procedural reliability was calculated as the number of correct steps divided by the total number of correct, incorrect, or omitted steps. The procedural reliability across the sessions for the 3 participants was 95%, with a range of 94 – 100%.

Data Analysis

Frequencies of correct selection of the initial letters of words presented in a dictation task were calculated for each probe, during the baseline, instruction, and maintenance phases. In order to demonstrate treatment effects, data were presented in graphic form to facilitate visual inspection of changes in level and slope of the data in each of the phases (Barlow & Hersen, 1984). The percent of non-overlapping data (PND) was also calculated: The number of data points in instruction that were above the level at baseline were divided by the total number of data points in instruction. Frequencies of correct responses were also calculated for the collateral measures: letter-sound correspon-

dence and the selection of initial letter in the writing tasks.

RESULTS

Selection of Initial Letter

Both Melinda and Haley were successful in acquiring the selection of the initial letter using the adaptive keyboard, when orally presented with single words in a dictation task (see Figure 1). Melinda required 14 instructional sessions to acquire the skill for all 5 target letters (i.e., s, d, c, f, b). She required 2 two instructional sessions to meet the criterion accuracy of 80% for s, 4r sessions for d, 2 sessions for c, 4 sessions for f, and 2 sessions for b. Melinda demonstrated maintenance of the skill for all 5 target letters at least 2 months following the completion of instruction, and was successful in maintaining the selection of initial letter at an accuracy level of 80%. The percent of non-overlapping data was 100%.

In addition to the maintenance probes, two generalization probes were administered to determine whether Melinda could segment the initial letters of novel words in response to pictures without the instructor providing an oral model of the words. Melinda achieved an accuracy of 92% on both of the generalization probes (23 out of 25 trials correct).

Haley required 10 instructional sessions, 2 sessions per letter, to acquire the selection of

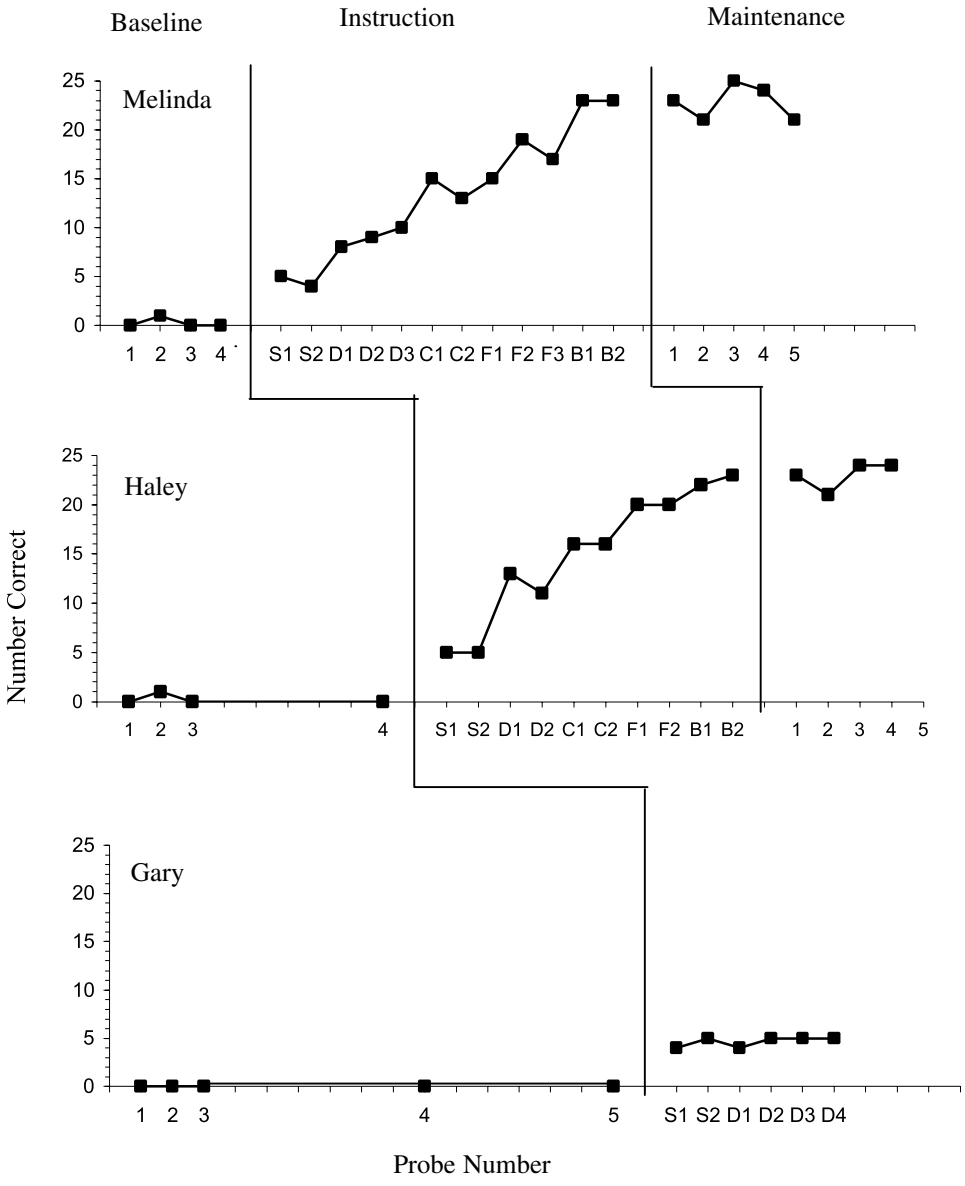

FIGURE 1 Frequency of correct selections of initial letters when orally presented with words in a dictation task during baseline, instruction, and maintenance phases for Melinda, Haley, and Gary.

initial letters for all 5 of the target letters. Haley was successful in maintaining an accuracy of at least 80% for the skill at least 1 month following the completion of instruction. The percent of non-overlapping data was 100%. Haley was also given two generalization probes to determine whether she could segment the initial letters of novel words without the instructor providing an oral model of the words. Haley demonstrated some generalization of the skill (i.e., an accuracy of 40 and 44%), but did not reach criterion for the generalization probes.

Gary did not reach criterion for the selection of initial letter for the 5 target letters. He achieved criterion for the selection of initial letter with the first target letter, s; he selected the letter, s on the adaptive keyboard as the initial letter for all of the items on the probes. Throughout the eight subsequent instructional sessions that focused on the second target letter, d, and which included a review of the first target letter, s, Gary demonstrated difficulty distinguishing between the two target letters. The instructional program targeting initial letter selection for words was discontinued with Gary following 10 instructional sessions and six probes. As an alternative, instruction was modified to focus on letter-sound correspondence alone.

Letter-Sound Correspondence

Melinda was successful in acquiring letter-sound correspondence for all 5 target letters in 10 instructional sessions. Furthermore, she was able to maintain the skill at least 2 months following the completion of instruction (see Figure 2).

Haley reached an accuracy level of at least 80% for letter-sound correspondence for all 5 target letters in four instructional sessions. She was successful in maintaining letter-sound correspondence for the target letters 3 days, 1 week, 2 weeks, and 1 month following the completion of instruction.

Gary demonstrated difficulty with the acquisition of letter-sound correspondence for the 5 target letters. Gary reached criterion for letter-sound correspondence for the first target letter, s. As with the selection of initial letter task, he frequently overgeneralized the selection of the letter, s, during the letter-sound correspondence instructional tasks and probes. The results of the probes suggested that he had difficulty distinguishing the target letters at the level of letter-sound correspondence. An error analysis was completed to identify patterns of Gary's selections. The results indicated Gary was overselecting 's' in all probes, suggesting he was unable to discriminate the target letters. See Table 2 for the error analysis.

A modified instructional program was developed for Gary, that incorporated several changes. First, the number of target letters was reduced from 5 to 4 (i.e., s, d, f, and c); the letter, b was eliminated so that Gary could visually discriminate the 4 letters easily. The instructional sessions were shortened to approximately 15 min to increase his time on task and to accommodate transient episodes of hemiplegia. The shorter sessions appeared to allow him to better focus on tasks and were less fatiguing. The instructional sessions focused on letter-sound correspondence only; the other two activities (i.e., selection of initial letter and the writing workshop-type activity) were eliminated. Instead of using the adaptive keyboard, 5 in laminated cards were made for the letters. After each trial, the order of the letters was rearranged so that Gary was required to visually search for the correct letter. Rearranging the cards each trial appeared more motivating and consistent with a game-type format.

After four instructional sessions, Gary met criterion for the two letters, s and d (see Figure 2, sessions D5 and D6). After the two instructional sessions to introduce the target letter, c, he reached an accuracy level of at least 80% for all three target letters (see Figure 2, session C1). Because of time constraints, it was not possible to continue the modified program with Gary. The results of the modified instructional program were shared with his personal care aide, mother, and speech-language pathologist so that they could continue the program.

Selection of Initial Letter in a Writing Task

Table 3 presents the data for the probes targeting selection of initial letter in a writing task for Melinda and Haley during baseline and maintenance. Both participants had a level of accuracy of 0% at baseline, and were successful in achieving an accuracy of at least 80%, with a range of 80 – 100% throughout the maintenance phase. Gary did not complete the instructional program, therefore there are no data reported for him.

DISCUSSION

Acquisition and Maintenance of the Selection of Initial Letter

The results demonstrated that the instructional program targeting the selection of initial letter was effective for 2 of the 3 children participating in the study. Melinda and Haley's acquisition and maintenance of the selection of initial letters

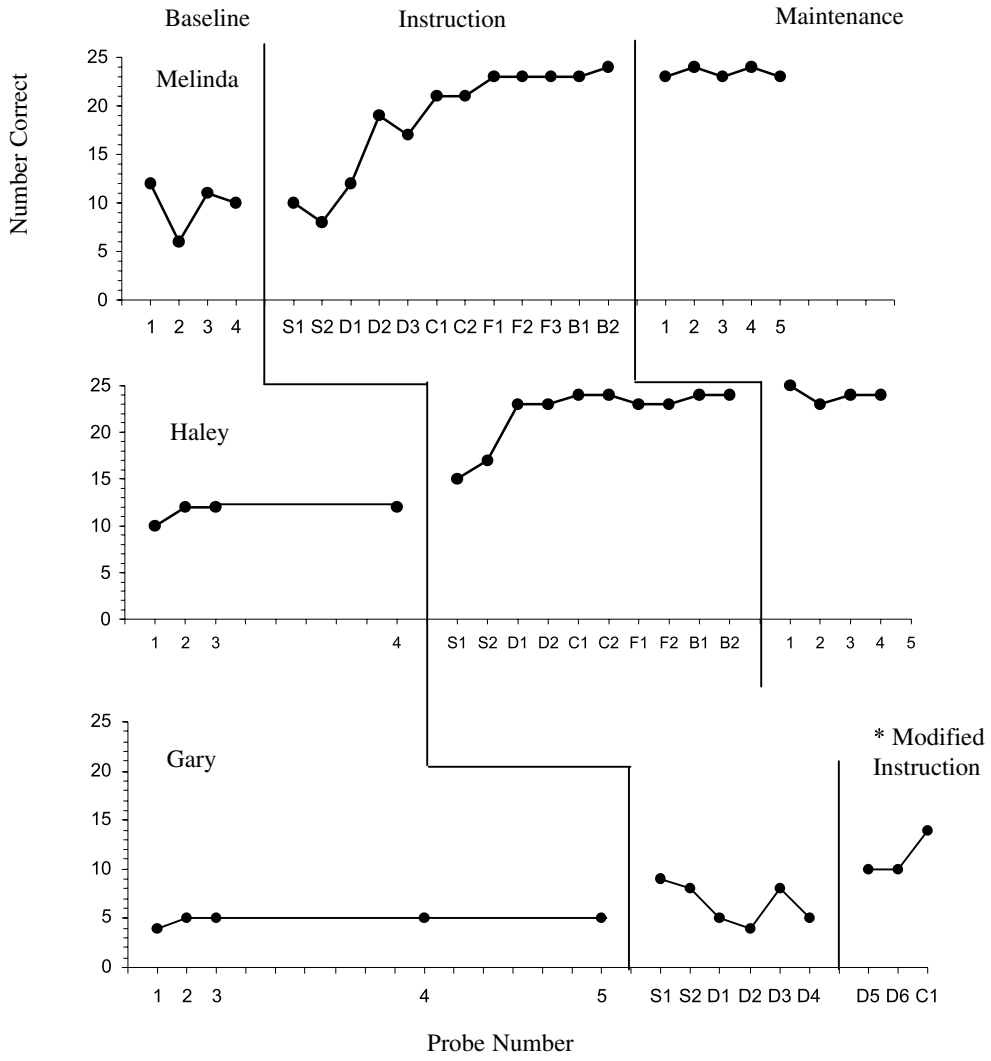

FIGURE 2 Frequency of correct selections of letter-sound correspondence during baseline, instruction, and maintenance phases for Melinda, Haley, and Gary.

TABLE 2 Error analysis for letter-sound correspondence probes administered during instruction for Gary

	Probe					
	S1	S2	D1	D2	D3	D4
s responses	16	18	11	15	17	14
d responses	2	1	6	3	2	2
c responses	3	2	2	3	2	2
f responses	3	1	6	2	3	4
b responses	1	3	0	2	1	3

Note: Each 25-item probe consisted of five trials targeting each of the target letters (i.e., s, d, c, f, and b) presented in random order. The numbers listed for each probe indicate correct and incorrect selections.

TABLE 3 Percentage of correct selections of initial letters in writing tasks for Melinda and Haley during baseline and maintenance

Session	Melinda	Haley
Baseline1	0%	0%
Baseline 2	0%	0%
Baseline 3	0%	0%
Maintenance 1	80%	100%
Maintenance 2	100%	80%
Maintenance 3	80%	80%
Maintenance 4	80%	100%
Maintenance 5	80%	–

supports the research with individuals with severe congenital speech impairments who also demonstrated the ability to acquire phonological awareness despite limited speech skills (e.g., Dahlgren Sandberg & Hjelmquist, 1996; Foley & Pollatsek, 1999). The findings based on 2 of the 3 participants in this study illustrate the suggestions that children who are at risk for difficulties

in developing functional literacy skills may benefit from explicit and systematic instruction in phonemic skills (e.g., Graham & Harris, 1994; Kameenui et al., 1997). In fact, Melinda and Haley acquired the selection of initial letters at approximately the same rate suggested for children without disabilities (i.e., approximately two instructional sessions for each new target letter introduced; see for example, Simmons & Kameenui, 1998).

The effectiveness of the program for 2 of the 3 participants may be attributed to several aspects: (a) the children were provided with frequent opportunities to practice the target skills in each instructional session (e.g., Simmons & Kameenui, 1998); (b) the most-to-least prompting hierarchy facilitated early success for the children and minimized the practicing of errors during learning (e.g., Simmons & Kameenui, 1998); (c) the lessons were structured to target only one letter at a time and instruction continued to mastery; and (d) each lesson included a review of previously mastered target letters (e.g., Simmons & Kameenui, 1998; Spiegel, 1992). The game format of the instructional tasks may also have contributed to maintaining the children's motivation and the overall effectiveness of the program. In addition, Melinda and Haley were also able to apply the use of the target skill to writing tasks. Because the instructional program was delivered as a package, it is not possible to conclude whether they would have performed as well with only structured activities and without the writing workshop-type activity. It has been suggested, however, that opportunities to engage in writing are necessary for children to learn applications of the skills beyond the subword level (e.g., Traweek & Berninger, 1997).

Gary demonstrated significant difficulty in acquiring the selection of initial letter and letter-sound correspondence. As a result, the program was discontinued with this participant. He did, however, participate in a modified instructional program to try to address the development of needed foundational skills. After six instructional sessions in the modified instructional program, Gary attained 93% accuracy with the letters s, d, and c in letter-sound correspondence activities. There are several potential explanations for Gary's success in the modified instructional program and lack of success in the original instructional program. The first explanation is that the original instructional program, which included activities that targeted selection of initial letter, letter-sound correspondence, and a writing workshop-type activity in one session, may have been too cognitively demanding. Research appears to indicate that children who are at risk for difficulties in the development of literacy skills may benefit from focused, explicit instruction in specific skills (Graham & Harris, 1994).

A second explanation for Gary's improved performance on the modified program could be that the sessions in the original program were too long for him. The sessions in the modified instructional program were shortened to approximately 15 min, approximately half the length of the sessions in the original instructional program. Furthermore, to keep his attention focused on the activity, cards with the target letters, s, d, c, and f in larger print were used, and the instructor rearranged the cards after each trial so that Gary would have to visually search for the correct letter.

A third explanation might be that Gary required some foundational work in letter-sound correspondence and initial letter skills in order to benefit fully from the instructional program as designed. Gary was successful in recognizing 70% of the letters by name at baseline; in contrast, Melinda had an accuracy of 88% and Haley was successful at an accuracy level of 96%. In addition, during the screening for the pool of target letters for the instructional program, Gary was unable to select any initial letters of single words correctly; Melinda, in contrast, selected two letters correctly and Haley selected 3 letters correctly. Because Gary had no prior knowledge of the selection of initial letter skill and had less letter-name knowledge than the other two participants, he may have required additional explicit instruction in these two skills compared to Melinda and Haley.

Generalization

The probes that were administered throughout the study incorporated a total of 305 words (61 per target letter) to assess generalization of the selection of initial letters to novel words. Each of the words included in the probes were used only 8 or 9 times across 28 probes. Because the words were randomly assigned to each probe and the order of probes was randomly assigned for each participant, there were approximately equal numbers of novel words in each list for the participants. Results from the probes demonstrate that Melinda and Haley learned to select initial letters for novel words starting with target letters.

In order to become independent writers, children need to be able to select letters without the provision of oral models of the words by an instructor. The instructional program provided scaffolding support through the instructor's oral model of each target word. Melinda was success-

ful in generalizing the selection of initial letter of novel words without an oral model of the word by the instructor; she had an accuracy level of 92%. Haley demonstrated some generalization, but only reached an accuracy level of 44%. The results suggest that Haley was still somewhat dependent on the instructor's oral presentation of the words. Haley's performance may have improved if there had been a component included in the instructional program that would have provided explicit instruction and practice in selecting the initial letters of words independently. The instructional activity might have been as simple as having the instructor model articulatory rehearsal of the word in order to facilitate subvocal articulatory rehearsal for the participants. Research has shown that individuals with congenital speech impairments typically have difficulty with tasks requiring articulatory rehearsal; therefore it is not surprising this was a challenging task (Foley, 1993).

Limitations and Future Directions

In a single subject design experiment using 3 participants, 2 of the 3 were successful with the writing program. This study contributes to the literature by providing further data on what has been effective and what has not been effective for 3 children who use AAC. There were several limitations that should be considered. Because of the small participant number that defines single case designs, the generality of the results were not demonstrated in this study. Future research is required to replicate the study across participants. Replication is particularly important because results of the intervention were mixed with only 2 of the 3 participants successfully acquiring the target skill within the constraints of this study. The mixed results suggest that the program may require modification to enhance the effectiveness of the instruction. Future research is needed to address adaptations for children like Gary, who may have difficulty attending to more than one task or who are in the very early stages of learning letter names and letter-sound correspondences.

A second limitation of the study is that the instructional program was developed as a package of activities targeting several skills; therefore, it is impossible to tease apart the effects of one instructional approach from the other. An issue for future research is the systematic investigation of the effects of the specific components of the instructional package, in order to design the most efficient and effective writing instruction. For some children, it may be more effective to teach each component skill to mastery before targeting others (i.e., letter-sound correspondence first, then selection of initial letter, and finally selection of initial letter in non-dictation types of tasks). Also warranted are investigations into alternative approaches to teaching the three skills, in order to determine the most efficient order or combinations for teaching these skills.

The instructional program used in the present study incorporated a modified writing workshop activity. The scope of story content was limited so that the children could practice initial letter segmentation and selection skills with the target letters. The impact of these constraints is unclear. A more child-directed approach to the writing workshop-type activity is suggested for future studies. Furthermore, the instructor modeled the construction of a story by telling (not writing) a story using the words the participants attempted. Modeling the writing of the story using the adapted keyboard may have encouraged the participants to select more than the initial letters of words in their own writing. Future research is also required into the factors that contribute to success in the generalization of the selection of initial letters to tasks in which the participants are not provided with an oral model by the instructor.

Another limitation of the study involved the design of the adaptive keyboard that was used in the activities. The keyboard included an array of 31 letters with the 5 target letters of instruction highlighted. Having the 5 letters highlighted may have restricted the scope of the responses that the children considered so that they selected letters from only the 5 highlighted letters. Error analyses of the probes administered during baseline and the early stages of instruction suggest that the participants selected letters from the entire array of 31 letters. The results of the error analyses, however, indicate that the participants mostly restricted their selections to the 5 highlighted target letters by the acquisition of the third target letter. Highlighting the letters provided additional scaffolding support and constrained the children's response options. Research is needed into the effects of the instructional programs without the target letters highlighted to determine if the children generalize skills to a larger array of response options.

In this study, we investigated the effects of an instructional program that targeted only initial writing skills. By the end of the instructional programs, the participants had not acquired sufficient skills to become independent, functional writers. The participants acquired only 5 letters from the entire set of 31 letters. Furthermore, they learned only selection of the initial letter of words. It is not clear how much additional

instruction would be required for participants to learn these skills with letters that were not included in instruction. We suggest further research into the effects of writing instructional programs targeting selection of letters in other positions (e.g., final) and other higher level skills.

Summary and Conclusions

The study provides a preliminary investigation of an instructional program to teach early writing skills to children who use AAC. Two of the 3 participants were successful in achieving the target skill of the instructional program, maintained use of the skill at least 1 month following instruction, and demonstrated some generalization of the skill to less structured tasks. Future research is required to determine evidence-based practices to improve the writing skills of individuals who require AAC. With enhanced writing skills, children who require AAC will be better prepared to participate in education, employment, and daily living.

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Notes

1 The DeltaTalker™ is a dedicated voice output communication aid. It can be set up with eight, 32, and 128 locations. It has a static display and can be accessed via direct selection or scanning. The DeltaTalker is manufactured by the Prentke Romich Company, 1022 Heyl Road, Wooster, OH, 44691, USA. Telephone: 1-800-262-1984. Website: http://www.prentrom.com

2 The Dynavox™ is a dedicated voice output communication aid with a dynamic display, weighs approximately 7 pounds, and may be accessed via direct selection or scanning. The DynaVox is manufactured by DynaVox Systems LLC, 2100 Wharton St, Suite 400, Pittsburgh, PA, 15203, USA. Telephone: 1-800-344-1778. Website: http://www.dynavoxsys.com/

3 The DynaMyte™ is a dedicated voice output communication system with a dynamic display. It is smaller than the DynaVox™; it weighs approximately 3 pounds. It may be accessed via direct selection or scanning. The DynaMyte™ is manufactured by DynaVox Systems LLC, 2100 Wharton St, Suite 400, Pittsburgh, PA, 15203, USA. Telephone: 1-800-344-1778. Website: http://www.dynavoxsys.com/

4 The Discover:Board™ is an alternative keyboard that can be customized for the user. The overlays may be designed for various keyboard layouts and sizes of keys. The DiscoverBoard™is manufactured by Don Johnston Incorporated, 26799 West Commerce Drive, Volo, IL, 60073, USA. Telephone: 1-800-344-1778. Website: http://www.donjohnston.com

5 Discover:Create™ is a software program used in conjunction with the Discover:Board™ to design the overlays. Discover:Create™ is manufactured by Don Johnston Incorporated, 26799 West Commerce Drive, Volo, IL, 60073, USA. Telephone: 1-800-344-1778. Website: http://www.donjohnston.com

6 Boardmaker™ is a graphics database containing over 3000 line drawings. Boardmaker™ is manufactured by Mayer-Johnson, Inc., P.O. Box 1579, Solana Beach, CA, 92075-7579, USA. Telephone: 1-800-588-4548. Website: http://www.mayer-johnson.com

7 CorelDRAW™ is a graphics software package used to create and edit color pictures. CorelDRAW™ is manufactured by Corel Corporation, 1600 Carling Avenue, Ottawa, Ontario, K1Z 8R7, Canada. Telephone: 1-800-772-6735. Website: http://www.corel.com

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