Comparing the Picture Exchange Communication System and Sign Language Training for Children with Autism

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This study compared the effects of Picture Exchange Communication System (PECS) and sign language training on the acquisition of mands (requests for preferred items) of students with autism. The study also examined the differential effects of each modality on students' acquisition of vocal behavior. Participants were two elementary school students with autism enrolled in a suburban public school. Training sessions involved presentations of preferred items, prompting and prompt fading procedures. Probes were conducted to evaluate the generalization of learned mands to classroom teachers. For one participant, sign language training produced a higher percentage of independent mands. PECS training produced a higher percentage of independent mands for the other participant. For both participants, sign language training produced a higher percentage of vocalizations during training. Mands learned with the experimenter generalized to classroom teachers. The results of the study suggest that acquisition of picture exchange and sign language may vary as a function of individual student characteristics, specifically, motor imitation skills prior to intervention. However, further research is needed to determine the optimal procedures for teaching both modalities to students with communication difficulties.

Speech deficits are common to children with autism (American Psychiatric Association, 2000). Approximately 50% of children diagnosed with autism will remain functionally mute in adulthood (Peeters & Gillberg, 1999). Even with early intensive intervention including speech instruction, some children may fail to acquire useful speech (e.g., Lovaas, 1987). Training in augmentative and alternative communication (AAC) is an option for children with autism who do not readily learn speech. Two AAC modalities, sign language and picture exchange, show promise for teaching communication to nonvocal learners.

In sign language training, children may be taught to mand or request preferred items, engage in conversation, and emit verbal behavior under the control of various stimulus conditions (cf. Sundberg & Partington, 1998). Although there has been little recent research on sign language intervention for children with autism, there is evidence that simultaneous communication training in teaching signs and speech produces favorable communication outcomes for children with autism and other developmental disabilities (e.g., Brady & Smouse, 1978; Konstantantareas, 1984; Layton & Baker, 1981). The Picture Exchange Communication System (PECS; Bondy & Frost, 2002), a popular picture exchange system used primarily for children with autism (National Research Council, 2001), teaches children to exchange picture symbols to mand and tact items, among other functions. Initial studies suggest that most children taught PECS acquire independent use of the system, and many even acquire functional speech (Bondy & Frost, 1994; Charlop-Christy et al., 2003; Schwartz, Garfinkle, & Bauer, 1998).

Given the positive reported outcomes for each modality, choosing between sign language and PECS may be difficult. Although some have argued for the benefits of teaching one AAC system over others (e.g., Sundberg & Partington, 1998), it is unlikely that any single system best meets the diverse needs of all children with autism and multiple disabilities. A number of factors, including cognitive and motor abilities, may influence a child's acquisition of an AAC system (Bonvillian & Blackburn, 1991). Four comparison studies of sign language and picture-based systems, described below, have yielded mixed and unclear evidence about the advantages and disadvantages of each system.

Hodges and Schwethelm (1984) taught 52 nonvocal children with mental retardation sign language and two types of picture-based systems. In the sign lan-

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guage condition, participants were taught to form hand signs to request preferred items (e.g., food). In the picture-based conditions, participants were taught to match picture symbols to food and nonfood objects and to assemble picture symbols into sentences. Sign language training produced more rapid acquisition and more correct responses than picture-based training; however, participants' acquisition of sign language may have been enhanced by the availability of preferred items only in this condition. The results of this study may therefore have limited generality to PECS, in which learners are taught to exchange picture symbols to mand preferred items from the beginning of training (see Bondy & Frost, 2002).

Extending Hodges and Schwethelm's (1984) study, Sundberg and Sundberg (1990) and Wraikat, Sundberg, and Michael (1991) taught adults with mild to moderate mental retardation to name, point to, and answer simple questions about a group of nonsense items with sign language and picture-based training. On average, participants showed fewer trials to criterion and greater response accuracy with sign language training. At least two factors may limit the generality of these findings to picture-based systems, such as PECS. First, participants were taught to point to picture symbols rather than to exchange them, as taught with the PECS system. Second, participants demonstrated "manual dexterity allowing for the formation of signs" (Sundberg & Sundberg, 1990, p. 33; Wraikat et al., 1991, p. 4) prior to intervention, but some nonvocal persons with developmental disabilities may have motor imitation difficulties that limit sign language acquisition (Seal & Bonvillian, 1997). Additionally, neither study compared the effects of training on participants' acquisition of mands, which is the first verbal operant taught within the PECS system.

In the only published study to examine sign language and PECS directly, Adkins and Axelrod (2001) compared sign language and PECS training for a child with pervasive developmental disorder. The participant exhibited fewer trials to criterion and more generalized responses in the PECS condition. Methodological problems, including the absence of systematic procedures for selecting preferred items and the failure to control for a history of exposure to each training modality prior to the study, may also limit the generality of these findings.

Comparison studies provide mixed and unclear evidence about the relative effectiveness of sign language and picture-based systems, including PECS. A particular question is the relationship of preexisting skills to the acquisition of each modality. Bondy and Frost (1994) suggested that PECS may be a better avenue of AAC training because it does not require the learner to have certain preexisting skills, such as imitation. Successful acquisition of sign language, in contrast, may depend on the learner's imitative skills prior to training. Another concern is the development of speech. Although the primary goal of AAC training is to teach communication skills, speech development may be a secondary benefit for some learners (Bondy & Frost, 1994; Charlop-Christy et al., 2003; Yoder & Layton, 1988). More research is needed to clarify the relationship of each modality to children's preexisting skills, including imitation, and subsequent speech development.

The purpose of this study was to compare the effectiveness of sign language and picture exchange training on the acquisition of mands (requests for preferred items) for children with autism. A particular question addressed by the study was the relationship of each modality to participants' preexisting motor imitation abilities. The study also examined the impact of each modality on the development of speech during training.

Method

Participants and Setting

The participants were two school-aged children with autism spectrum disorders, enrolled in a self-contained classroom for children with multiple disabilities within a public school. The participants were selected for the study because of their inabilities to use functional speech. Each participant used gesturing as his or her primary means of communication. Experimental sessions occurred in the children's self-contained classroom.

Carl was a 5-year, 10-month-old African American male with diagnoses of autism and mental retardation. A recent administration of the *Childhood Autism Rating Scale* (CARS; Schopler, Reichler, & Renner, 1988) placed Carl within the severely autistic range. Anecdotal reports from teachers and classroom observation by the author indicated that he could vocally imitate some words, but did not use speech to communicate without teacher prompts. Jennifer was a 6-year, 8-month-old Asian American female with a diagnosis of pervasive developmental disorder—not otherwise specified (PDD-NOS). A recent administration of the *Gilliam Autism Rating Scale* (GARS; Gilliam, 1995) suggested an average degree of autistic severity. A recent administration of the *Developmental Profile–II* (Alpern, Boll, & Shearer) indicated an IQ equivalence score of 54 for Jennifer, suggesting a moderate degree of mental retardation. Anecdotal reports from teachers and classroom observation by the author indicated that she could vocally imitate some words and phrases. She did not use speech to communicate without teacher prompts.

Design

The study used an alternating treatments design with initial baseline phase and final "best-treatment" phase (Cooper, Heron, & Heward, 1987) to compare the effects of sign language and picture exchange training. Following baseline, Carl and Jennifer received sign language and picture exchange training in alternating treatments. Treatments were counterbalanced across days of the week, time of day, order of presentation, and persons delivering the treatment to reduce the likelihood of variables other than the treatments influencing the target behav-

ior. In the best-treatment phase, only the most effective training modality was administered to teach requests. The best treatment for Carl was sign language training, while for Jennifer it was PECS training.

General Procedures

Stimulus Preference Assessment. A stimulus preference assessment (Pace et al., 1985) was conducted to identify preferred items to be used in communication training. Potentially reinforcing items, including drinks and edibles, sensory toys, and other toy items were presented one at a time to each participant. The participant's response to each item, including whether the item was consumed (if food or drink) or played with (if a toy), was recorded. A list of 10 to 12 preferred items was created for each participant based on his or her responses. Preferred items were assigned randomly to picture exchange and sign language training conditions, so that an equal number of items were in each condition.

Imitation Assessment. Imitation skills were assessed prior to intervention to determine the relationship of participants' preexisting imitation abilities to acquisition of sign language and picture exchange. Each participant was assessed on a list of 27 hand, arm, and finger movements that were similar to those required to perform sign language (Sundberg & Partington, 1998). The experimenter presented the vocal instruction, "Do this," while modeling each movement. Participants were given verbal praise and brief access to preferred items for attending to the experimenter (e.g., facing the experimenter, making eye contact) and making response attempts. The experimenter did not give praise or access to preferred items specifically for correct responses. Imitation assessment continued for two sessions or until all movements had been assessed twice.

Baseline. The purpose of baseline was to ensure that participants did not have a preexisting ability to request the preferred items with picture exchange, speech, or sign language. Items identified in the stimulus preference assessment were presented to participants one at a time in random order. Following a brief period of noncontingent access (10–20 seconds), each item was removed from the participant and re-presented within view, but out of arm's reach. A laminated 2" × 2" picture symbol of the item was placed in front of the participant. Any attempts to reach for the item were blocked (e.g., the item was moved out of the child's reach). If the participant placed the picture symbol in the hand of the experimenter, signed the name of the item, or said the name of the item within 10 seconds, the experimenter gave access to it. If not, the item was removed and the next item on the list was presented until all items on the list had been presented.

Sign Language Training. The procedures for sign language training were partially adapted from Sundberg and Partington's (1998) *Teaching Language to Children with Autism or Other Developmental Disabilities.* The simplest American Sign Language sign that conveyed the meaning of each item was taught. When possible, iconic signs that resembled their items were taught. For example, the sign for a Slinky toy was the formation of a hand sign that resembled a Slinky. To avoid potential confusion between signs, none of the hand signs selected for each participant topographically resembled each other. Items selected for sign training were presented to the participant in quasi-random order. To decrease the likelihood of participant satiation, edibles, sensory toys, and other items were interspersed during training. To ensure that each item was currently reinforcing, the experimenter presented the item to the participant before training. If the participant reached for the item, the experimenter gave noncontingent access to the item for a brief period (10–20 seconds). If the item was food or drink, the participant was given a small amount of the item (i.e., 45 ml of a drink in a small cup or one bite-sized piece of an edible). Sign language training then began for that item. If the participant did not reach for the item, the next item was presented. The same procedures were repeated until the participant reached for an item.

Sign language training involved two persons: the experimenter, who sat in front of the participant and acted as the listener, and a second trainer, who delivered prompts while seated behind the participant. During each training presentation, the experimenter presented the item, then signed the name of the item and simultaneously provided a vocal model (e.g., said "cookie"). The experimenter did not ask the participant if he or she wanted the item (e.g., "What do you want?") to prevent prior vocal stimuli from gaining stimulus control over the response. If the participant did not correctly sign the name of the item following physical and vocal models from the experimenter, the second trainer physically prompted the participant from behind to sign the name of the item (i.e., put participant's hand in correct formation). This prompting strategy ensured a correct response for each item presentation. After the participant performed the correct sign, with or without assistance, the experimenter immediately allowed access to the item.

The experimenter used progressive time delay (Green, 2001; Snell & Gast, 1981) to gradually increase the time between presentation of the item and vocal and modeling prompts by up to 4 s. When the participant performed the correct sign before the prompt, the experimenter provided a vocal and physical model of the sign and gave immediate access to the item. The second trainer continued to provide physical assistance as necessary.

Sign language training with the selected item continued for five to seven trials, or until the participant satiated on the item. Satiation was indicated when the participant made no attempt to sign for the item, did not reach for the item, or did not eat, drink, or play with the item when given access. When satiation occurred, the next item on the list was presented to the participant following the same procedures until all items on the list were presented during the session.

PECS Training. As in the sign language training, items for PECS training were presented in quasi-random order, with edibles, sensory toys, and other items interspersed to reduce the likelihood of satiation. Each item was presented noncontingently one time, followed by training trials. Training trials for each item continued for five to seven trials, or until the participant satiated on the item. Training procedures were adapted from Bondy and Frost's (2002) *Picture Exchange Communication System Training Manual.* Two trainers were used for PECS training: the listener or exchange partner who was seated in front of the participant and the second trainer or prompter who was seated behind. Phases I through III of Bondy and Frost's PECS training were implemented: (a) teaching the unassisted exchange; (b) increasing distance from the speaker to the exchange partner and increasing distance from the exchange partner to the participant's communication book; and (c) teaching discrimination between picture symbols (see Bondy & Frost, 2002, for a detailed description of PECS procedures).

Specific procedures for each phase of training were as follows: In Phase I, the exchange partner (experimenter), seated in front of the participant, presented a reinforcing item. The exchange partner provided no prompts or cues for the participant to exchange a picture to request the item; rather, the second trainer, seated behind the participant, provided physical assistance to pick up and exchange the picture symbol. The second trainer gradually faded her physical assistance from full physical (i.e., hand-over-hand) to partial physical prompts, until the participant required no prompting to make an independent picture exchange. As in the sign language training, the prompt fading procedures used in PECS training resulted in a correct response for every opportunity presented.

When the participant was able to exchange a picture symbol with 80% or greater independence across two consecutive PECS training sessions, Phase II began. In Phase II, the picture symbol was placed on the front of a communication book, and the exchange partner gradually moved a distance of up to 5 m from the participant. The communication book was also gradually moved a distance of up to 5 m away from the participant. As in Phase I, the second trainer provided physical prompts from behind for the participant to travel to the exchange partner and communication book, and gradually faded these prompts until none were necessary. Training at Phase II continued until the participant was able to travel to the exchange partner and communication book at varying distances with 80% or greater independence across two consecutive sessions.

Finally, in Phases IIIa and IIIb, the participant was taught to select and exchange a picture symbol from an array of picture symbols in the communication book. In the first phase of training, IIIa, the participant was taught to discriminate between a preferred and a nonpreferred picture symbol. Picture symbols for each item were available on the front of the communication book, placed in front of the participant. If the participant gave the experimenter the picture symbol for the preferred item, he or she received that item. If the participant gave the experimenter the picture symbol for the nonpreferred item (error), the experimenter performed the following correction procedure:

1. modeled the correct response by removing the correct picture symbol from the book, presenting it to the participant, and saying the name of the symbol/object
2. prompted the participant to pick up the correct symbol by pointing to it and allowing the participant to exchange the symbol, but not giving the participant access to the item
3. turned the book over and paused for approximately 3 s
4. presented the book again, allowing the participant to request the preferred item

If the participant made two consecutive errors, the same procedure was followed, except in Step 3, the nonpreferred picture symbol was removed to ensure participant success (i.e., an errorless trial).

Training continued at this level until the participant was able to discriminate between one preferred item picture symbol and one nonpreferred item picture symbol for 80% of trials across two sessions. In the next phase of training, IIIb, the participant was taught to discriminate between two or more preferred picture symbols (i.e., two reinforcing items for the participant). To begin, the experimenter presented two preferred item picture symbols to the participant. Picture exchanges were reinforced in the same manner as described above. On the average of every third trial, the experimenter conducted a correspondence check to ensure the accuracy of picture discriminations. Correspondence checks were conducted as follows: After the participant performed the picture exchange, the experimenter presented both items in his hand, a plate, or a tray with the instruction, "Take it." If the participant reached for the item requested, the experimenter gave the participant that item. If the participant reached for the other item, the experimenter performed the correction procedure described above. If the participant made two consecutive errors, the same procedure was followed, except in Step 3, the currently nonpreferred picture symbol was removed to ensure the participant's success (i.e., an errorless trial). Training continued at this phase until the participant discriminated between two preferred item picture symbols for 80% of presentations across two sessions. When the student achieved this criterion, additional preferred item picture symbols were gradually added to the communication book.

Generalization Probes. Generalization probes were conducted during PECS and sign language training. A listener other than the experimenter, such as a teacher or teaching assistant from the participant's classroom, was introduced to assess the generalization of requests to new persons. As in the training sessions, the listener sat across from the participant and presented preferred items to the participant one at a time. Physical and modeling prompts were provided as nec-

essary for the participant to perform the correct response. Six generalization probes were conducted for each participant.

Social Validity

The purpose of social validity assessment is to "evaluate the acceptability or viability of a programmed intervention" (Schwartz & Baer, 1991, p. 189). Because participants in this study were primarily nonverbal, secondary consumers, the teacher and parents were administered social validity assessments. The assessments were written questionnaires, administered and scored by the author. They asked the following questions:

1. How important was the study to understanding communication training for children with autism and related disabilities?
2. Which modality of training was more effective for participants in the study?
3. Which modality of training would be more feasible to implement?
4. Which modality of training are you more likely to implement in the future?
5. Generally, how did participation affect the study's participants?

Procedural Modifications

Carl. During the first five sessions of sign language training (Sessions 5, 8, 9, 11, 14), Carl emitted a high rate of responses prompted by the experimenter's model. Even though the topographies of his signs were accurate, he consistently waited until the experimenter presented a model of the hand sign to respond. Experimental control apparently failed to transfer from modeling prompts to natural cues and establishing operations (i.e., presentations of items, food or drink deprivation). To free stimulus control from modeling prompts, they were removed from training. Specifically, after a preferred item was presented, if no response was emitted, the second trainer provided a physical prompt from behind using a progressive time delay. The second trainer faded her prompts gradually to the least amount necessary to produce a correct response, waiting up to 4 s for the participant to emit a correct response. The experimenter did not provide any prompts, but when Carl performed the correct response, the experimenter provided vocal and sign models and gave immediate access to the item.

Jennifer. Jennifer exhibited a decline in word vocalizations during PECS training Sessions 13 through 30. A reinforcement delay procedure was implemented during Sessions 31 through 33 to increase her rate of word vocalizations. PECS IIIb training procedures were the same, except that after she placed the picture symbol in the hand of the experimenter, he delayed the delivery of the preferred item by up to 4 s, until Jennifer emitted a word vocalization. If she did not emit a word vocalization by the end of the 4-s interval, the preferred item was delivered.

Dependent Variables and Data Collection

There were three categories of dependent variables in this study: motor imitation, mands, and word vocalizations. All dependent variables were measured with event recording, and all data on the dependent variables were collected by the author (primary observer). A motor imitation was recorded as correct when, in response to the experimenter's instruction, "Do this" and a model, the participant performed the corresponding hand movement. A motor imitation was recorded as incorrect when, in response to the experimenter's instruction, "Do this" and a model, the participant performed a hand movement other than the one modeled by the experimenter. If the participant performed no hand movement in response to the experimenter's instruction, a nonresponse was recorded.

A sign language mand was recorded as independent when, in the presence of an item, the participant performed the correct sign for the item without prompts to access it. A response was recorded as prompted if the participant performed the correct sign after an experimenter model, or the participant required a physical prompt to perform the correct sign.

A picture exchange mand was recorded as independent when the participant exchanged a picture symbol with the experimenter to access a preferred item. Specifically, the participant picked up a picture symbol for the corresponding item with his or her hand and placed the picture symbol in the experimenter's hand. If the experimenter sat or stood some distance from the participant, the participant had to walk to the experimenter to complete the picture exchange. A picture exchange was recorded as prompted if the participant required a gestural or physical prompt to pick up the picture symbol, walk to the experimenter, or place the picture symbol in the experimenter's hand. An open-hand cue (i.e., extending one's open hand as a prompt to exchange a picture symbol) by the experimenter was counted as a gestural prompt.

A word vocalization was recorded if, in response to the presentation of an item, the participant clearly said the correct name of the item (e.g., "cookie"). A word vocalization was not recorded if, in response to the presentation of an item, the participant did not clearly say the name of the item, said an incorrect approximation of the item (e.g., "cook," "c," or "kee"), said the name of another item (e.g., "apple"), or said nothing.

Interobserver Agreement and Procedural Integrity

For interobserver agreement and procedural integrity in data collection, the author was the primary observer, while four undergraduate research assistants were rotated as secondary observers. Prior to conducting interobserver agreement checks, the author described the various response definitions and teaching procedures to the secondary observers, who subsequently scored data during practice sessions until they obtained at least 80% interobserver agreement with the author. To assess the believability of data, two observers simultaneously collected data on participant responses for 27.1% of the

sessions, distributed randomly. Interobserver agreement was calculated by point-by-point ratio (Kazdin, 1982). Mean interobserver agreement on the dependent variable for all conditions was 94% (range 60.8%–100%). Procedural integrity was evaluated by two persons completing a checklist of experimental procedures for 26.3% of the sessions, distributed randomly. Figures 1 and 2 show examples of procedural integrity checklists for PECS Phase I training and sign language training. "Yes" responses on the checklist indicated compliance with experimental procedures. The primary observer obtained a mean percentage of "Yes" responses for all conditions of 97.1% (range 80%–100%). The mean interobserver agreement for treatment integrity was 96.8% (range 75%–100%).

Student: _____ Session #: _____

Observer: _____ Date: _____

Condition: PECS Training – Phase I Interobserver agreement: Y / N

Item:

1. **(If presenting item for first time)** Experimenter places preferred item in front of student; hands item to student.	Y / N / NA
2. **(If presenting item for first time)** If student does not reach for, play with, or eat/drink the item, the item is withdrawn (skip to next item).	Y / N / NA
3. **(If presenting item for first time)** Experimenter allows brief access to the item for 10–20 seconds. If the item is food or drink, the student is given a small amount of the item (i.e., 45 ml of a drink in a small cup or one bite-sized piece of an edible) and is allowed to access the item until finished.	Y / N / NA
4. **(If presenting item for first time)** Experimenter removes item from student, if necessary.	Y / N / NA
5. Experimenter presents preferred item to student.	Y / N
6. If the student does not pick up the picture symbol and place it in the hand of the experimenter, the second trainer physically prompts the student from behind to place the picture symbol in the hand of the experimenter.	Y / N / NA
7. When the picture symbol has just touched the hand of the experimenter, he or she holds up the picture symbol and says the name of the item (e.g., "cookie").	Y / N
8. The experimenter gives immediate access to the item.	Y / N

FIGURE 1. Sample procedural integrity checklist for PECS Phase I training.

Results

Imitation Assessment

Carl demonstrated moderate motor imitation skills, imitating 43% of hand movements correctly out of 76% response attempts. Jennifer, in contrast, demonstrated weak motor imitation skills, imitating just 20% of hand movements correctly out of 78% response attempts. Carl correctly imitated more than twice as many hand movements as compared with Jennifer.

Sign Language and PECS Training

Carl. Independent mands emitted by Carl during training are shown in Figure 3. In baseline, he emitted no mands, even though he reached for preferred items during most presentations. In alternating treatments Sessions 4 through 14, Carl's independent mands increased to an average of 2.1% (range 0%–3.8%) in sign language training, and an average of 17.9% (range 0%–39.2%) in PECS I training. In alternating treatments Sessions 15 through 25, sign language training was modified to increase Carl's independent responses. During Sessions 15 through 25, his independent mands increased to an average of 34.1% (range 25%–46.4%) in sign language training, and decreased to an average of 7.6% (range 0%–16.3%) in PECS training. Visual inspection of the data in Sessions 15 through 25 revealed a fractionation of the sign language and PECS training data paths, with sign language training producing a higher percentage of independent mands. It was, therefore, decided to implement sign language training alone in the final best-treatment phase of the study. In Sessions 26 to 31 of sign language training, Carl emitted an average of 38.9% independent mands (range 14.2%–40%).

Jennifer. Independent mands performed by Jennifer are displayed in Figure 4. In baseline, she emitted no mands in either condition, even though she reached for preferred items during most presentations. In alternating treatments Sessions 4 through 21, Jennifer's independent mands increased to an average of 12.9% (range 0%–25%) in sign language training, and an average of 59.6% (range 12%–100%) in PECS I training. On average, Jennifer emitted more than three times as many independent mands in PECS I training than in sign language training. Visual inspection of the PECS data path from Sessions 4 through 21 indicates an increasing trend in independent responses. In contrast, visual inspection of the sign language data path indicates a leveling of independent responses after the first two sessions. The highest percentage of independent responses (25%) in Jennifer's sign language training sessions was for the sign "truck" for toy truck. "Truck" was the only sign for which Jennifer demonstrated any significant percentage of independent responses.

Student: _____ Session #: _____

Observer: _____ Date: _____

Condition: Sign Language Training Interobserver agreement: Y / N

Item:

1. **(If presenting item for first time)** Experimenter places preferred item in front of student; hands item to student.	Y / N / NA
2. **(If presenting item for first time)** If student does not reach for, play with, or eat/drink the item, the item is withdrawn (skip to next item).	Y / N / NA
3. **(If presenting item for first time)** Experimenter allows brief access to the item for 10–20 seconds. If the item is food or drink, the student is given a small amount of the item (i.e., 45 ml of a drink in a small cup or one bite-sized piece of an edible) and is allowed to access the item until finished.	Y / N / NA
4. **(If presenting item for first time)** Experimenter removes item from student, if necessary.	Y / N / NA
5. Experimenter presents preferred item to student.	Y / N
6. If student does not sign the name of item, the experimenter signs the name of the item (physical model) and provides a vocal model (e.g., "cookie").	Y / N / NA
7. If the student does not correctly sign the name of the item with physical and vocal models, the second trainer physically prompts the student from behind to sign the name of the item.	Y / N / NA
8. When student performs correct sign, the experimenter gives access to the item.	Y / N

FIGURE 2. Sample procedural integrity checklist for sign language training.

Visual inspection of Jennifer's data in Sessions 4 through 21 revealed fractionation of the sign language and PECS training data paths, with PECS I training producing a higher percentage of independent mands. It was, therefore, decided to implement PECS training alone in the final best-treatment phase of the study. PECS Phase II training was implemented during Sessions 22 to 24; PECS Phase IIIa training was implemented during Sessions 25 through 27; and PECS Phase IIIb training was implemented in Sessions 28 through 33. Jennifer emitted an average of 95.3% independent mands (range 82.1%–100%) in the best-treatment phase of the study.

Word Vocalizations

Carl. Word vocalization data for Carl are shown in Figure 5. In baseline, he emitted no word vocalizations. In sign language training Sessions 5 through 24, Carl emitted an average of 46.3% word vocalizations (range 20%–64.2%). In PECS training Sessions 4 through 25, he emitted an average of 22.3% word vocalizations (range 4.3%–45.8%). On average, Carl emitted more than twice as many word vocalizations in sign language training than in PECS training. In the best-treatment phase (sign language only; Sessions 26 through 31), Carl emitted an average of 32.6% word vocalizations (range 17.6%–53.3%). Word vocalizations declined, on average, by 13.7% from the previous sign language training phase.

Jennifer. Jennifer's word vocalization data are depicted in Figure 6. In baseline, she emitted no word vocalizations. In sign language training Sessions 5 through 21, she emitted an average of 93.4% word vocalizations (range 64.7%–100%). In PECS training Sessions 4 through 20, she emitted an average of 77.9% word vocalizations (range 46.6%–100%). A decreasing trend in word vocalizations in PECS training began during Session 13 and continued during Sessions 14, 16, 17, and 20. In contrast, the percentage of word vocalizations in sign language training remained consistently high (88%–100%) during Sessions 12, 15, 18, 19, and 21. Interestingly, the decline in word vocalizations during Sessions 14, 16, 17, and 20 of PECS training coincided with an increase in independent picture exchanges (see Figure 4). For Jennifer, the data indicate that sign language training produced more word vocalizations than PECS I training.

During Sessions 22 through 30 of best treatment, the declining trend in word vocalizations continued. Jennifer emitted an average of 52.3% word vocalizations (range 44%–65.2%) during PECS Phase II training (Sessions 22–24), 56.1% word vocalizations (range 50%–68.4%) during PECS Phase IIIa training (Sessions 25–27), and 30.1% word vocalizations (range 25%–36.8%) during the first three sessions of PECS Phase IIIb training (Sessions 28–30). During Sessions 31 through 33 of Phase IIIb training, a reinforcement delay procedure was implemented to increase the percentage of vocalizations. Word vocalizations increased significantly, to an average of 90% (range 80%–100%).

Generalization

Overall, results for generalization probes were similar to training. Carl emitted an average of 0% independent picture exchanges and 34% independent signs. In contrast, Jennifer emitted an average of 94% independent picture exchanges, but only 66% independent signs. All of Jennifer's independent signs were the topography for "truck," reflecting her failure to acquire any other sign during training.

Social Validity

Overall, the teacher's responses to questions regarding the procedures and results of the study were positive. She be-

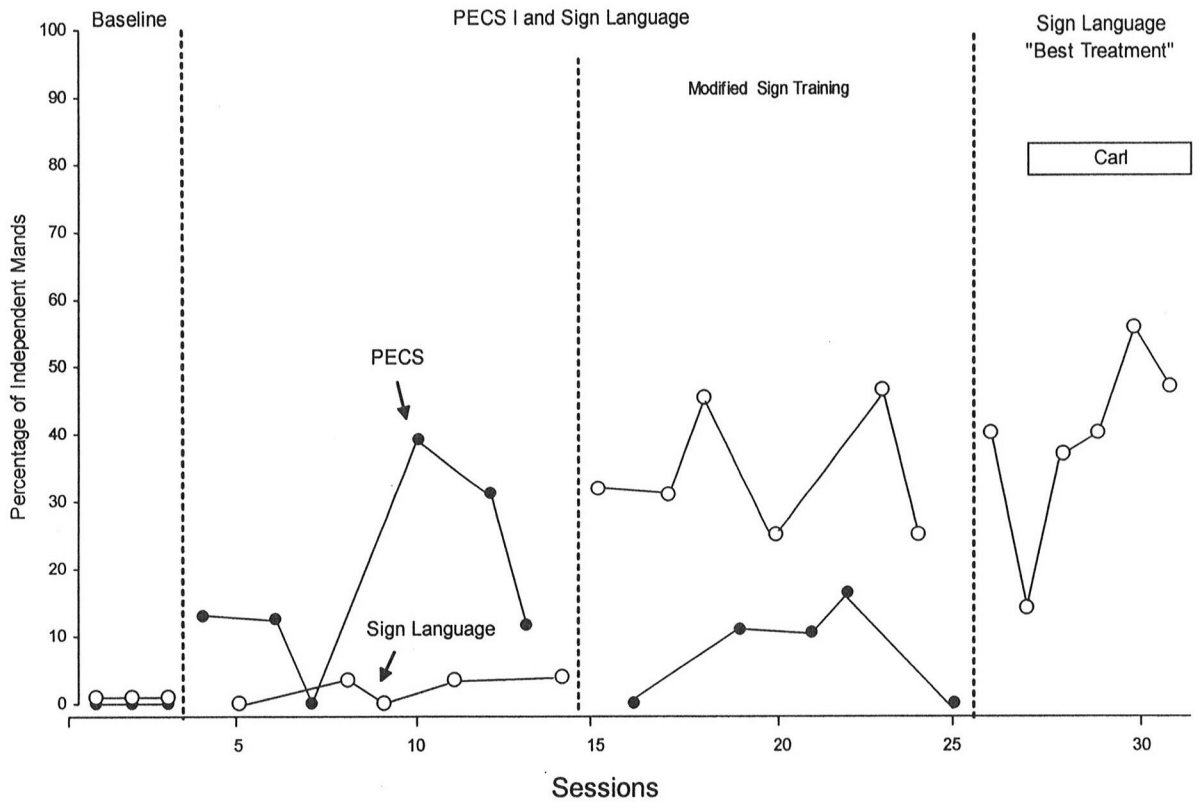

FIGURE 3. Percentage of independent mands during sign language and PECS training, and best treatment for Carl.

lieved that the procedures of the study were important for understanding AAC for children with autism and related disabilities. She also indicated that the results of the study were important for the intervention of such students. With regard to the usefulness and feasibility of PECS versus sign language, she believed that the usefulness of either modality varied depending on the characteristics of each student, and that it would be feasible to incorporate either PECS or sign language into her classroom. When asked about which modality she was most likely to use with her students, she said that she was equally likely to use sign language and PECS. She said that her students, Carl and Jennifer, benefited from the one-to-one instruction given in the study and felt that they did learn to communicate better as a result of the study's procedures. Finally, she disliked the alternation between sign language and PECS training for Carl and Jennifer, saying that both students would have learned more if exposed to just one modality.

Parents gave different, but generally positive responses concerning the impact of the study on their children. Carl's father said that the study improved his child's communication skills at home. Jennifer's mother indicated that she was not sure how the study affected her child's communication skills. Regarding which modality of communication was most useful with their child, Carl's parents liked sign language, while Jennifer's mother liked PECS. Parents' social validity data should be interpreted with caution because no intervention occurred in the home setting.

Discussion

Results of this study suggest mixed findings for teaching mands using sign language and PECS training. For learners without hand-motor imitation skills, including many children with autism, PECS training may be more appropriate, at least in terms of initial mand acquisition. Jennifer had weak hand-motor imitation skills prior to intervention and learned picture exchange more rapidly than sign language. For learners who have moderate hand-motor imitation skills, sign language training may be equally, if not more, appropriate. Carl had moderate imitation skills prior to intervention and learned sign language more rapidly than picture exchange. Sign language training produced more vocalization for Carl and Jennifer; however, a procedural modification to the PECS system increased Jennifer's vocalization to a level similar to that in sign language training. Procedural modifications to the PECS system may be necessary to increase and sustain vocalization for some children.

The results of the current study do not replicate those of Sundberg and Sundberg (1990) and Wraikat et al. (1991), who found better response acquisition with sign language training. The differences in findings may be due, in part, to differences in participant selection procedures. Prior to intervention, participants

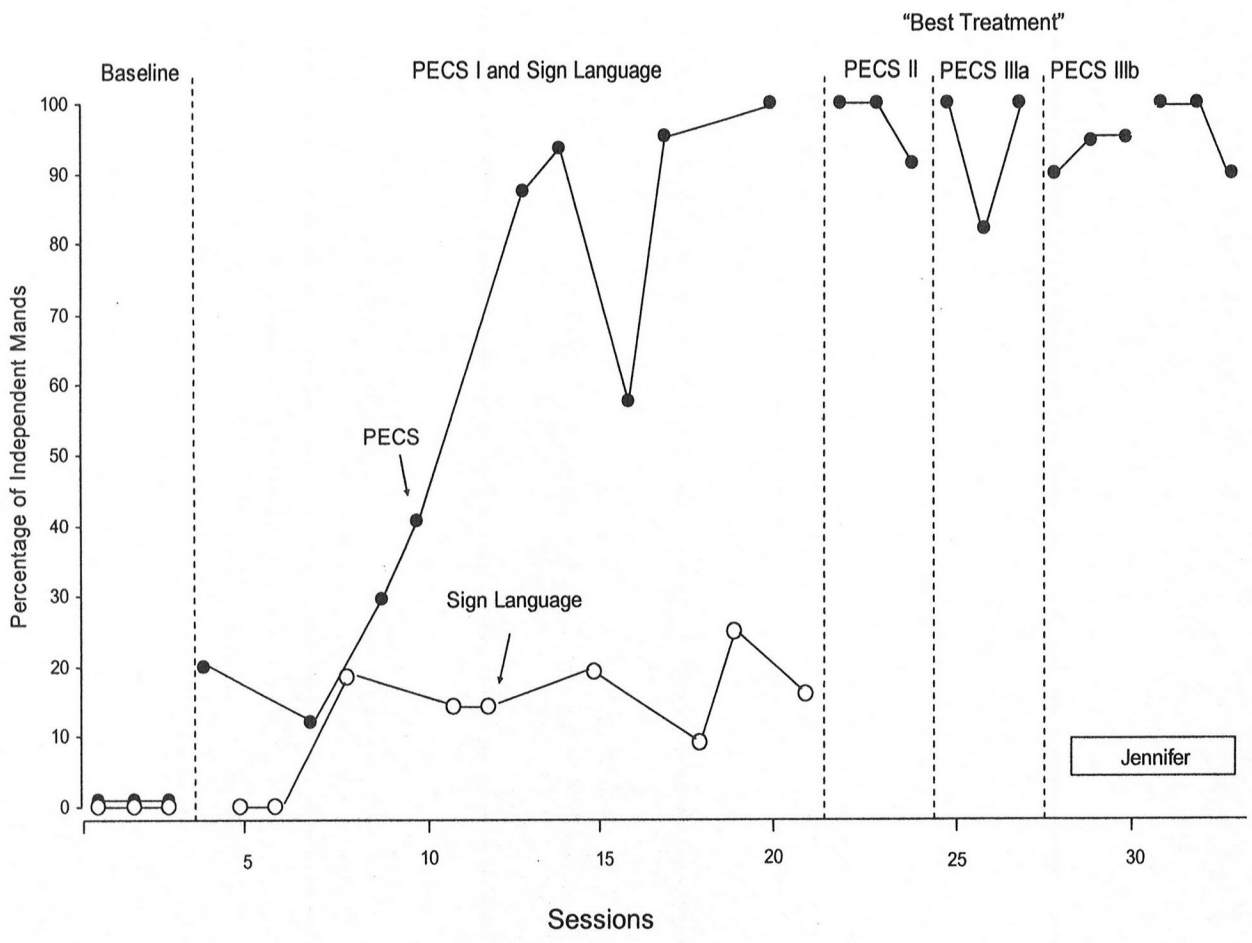

FIGURE 4. Percentage of independent mands during sign language and PECS training, and best treatment for Jennifer.

in these studies demonstrated the manual dexterity that allowed sign formation, while participants in the current study demonstrated mixed motor abilities.

Carl failed to exhibit a significant percentage of independent signs until modeling prompts were removed from training. Carl's data suggest that children who have imitative skills may continue to rely on imitative prompts, even when time delay prompt fading procedures are used. Optimal sign language training may begin with imitative prompts, switching to physical prompts when the student has acquired the correct sign topographies. Or, sign language training may begin with a second trainer who provides physical prompts from behind, an adaptation of the PECS training procedures (Bondy & Frost, 2002).

In contrast to the mixed results for mand acquisition, sign language training produced more speech for Carl and Jennifer. The reason for increased vocal production during sign language training is unclear, but may relate to the evocative effect of hand signs on vocalizations. Observational data suggest that Carl and Jennifer often vocalized immediately after they performed a sign, indicating that signs may have functioned as self-prompts for vocalization. In PECS training, however, Carl and Jennifer generally waited for the exchange partner to provide a model before they vocalized. Carl's word vocalizations decreased during the best-treatment phase of sign language training for unknown reasons. Still, on average, Carl emitted approximately one third more vocalizations in the best-treatment phase of sign language training than in PECS training. Bondy and Frost (1994) reported that vocalizations generally developed during the later phases of PECS training (Phases IV to VI). The current study only taught PECS with Phases I to III of training. Therefore, the results of the current study may not generalize to children who participate in the latter phases of PECS training. Further, adding the reinforcement delay procedure to PECS training appeared to increase Jennifer's speech. Delaying the delivery of the requested item by up to 4 s may therefore increase vocalization for some children.

Probes conducted for Carl and Jennifer indicated evidence of generalization of picture exchange and sign language to new persons. Percentages of independent

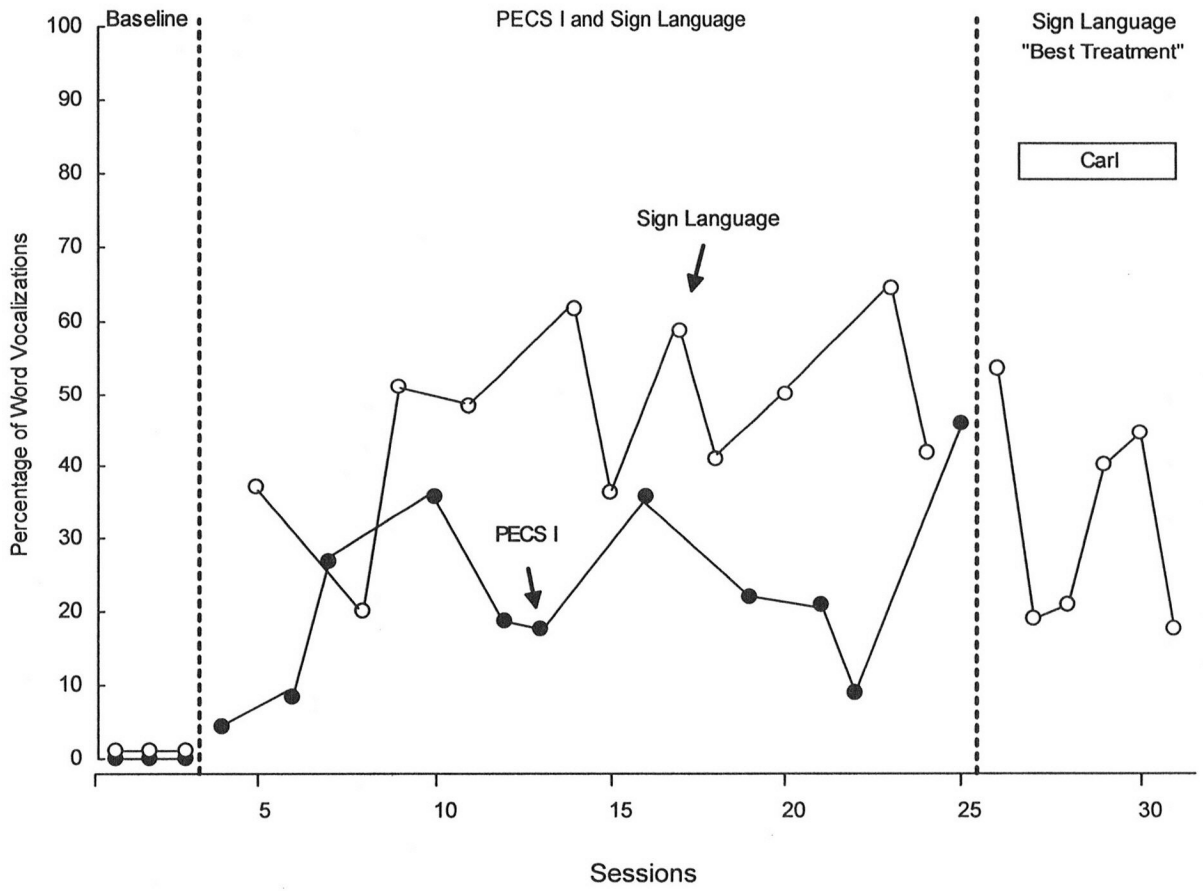

FIGURE 5. Percentage of word vocalizations in baseline and training conditions for Carl.

responses in generalization sessions were similar to those in training for Carl and Jennifer. The current study used only one listener to teach sign language and picture exchange. Sundberg and Partington (1998) and Bondy and Frost (2002) recommend using multiple listeners to promote generality across persons. Generalization of responses in the current study may have been limited by the use of only one listener.

There were a number of procedural limitations in this study. One limitation was the stimulus preference assessment, which used sequential presentation of single items. Poor reinforcer strength may have weakened participants' acquisition of picture exchanges and sign language. A more rigorous assessment involving forced choice of two items presented simultaneously and rank ordering of items (Fisher et al., 1992) might have better teased out stimulus preference, improving participants' mand acquisition. Despite the potential weakness of the reinforcer assessment used in the study, Carl and Jennifer reached for items during most initial presentations, suggesting that the preferred items were consistently reinforcing for these participants.

A second limitation was the setting, a public school, which was subject to a number of fluctuating circumstances that may have threatened internal validity, including the entering and exiting of students and staff from the classroom, frequent staff changes and substitutions, and a classroom schedule which varied considerably from day to day. As a result, participants were sometimes distracted during experimental sessions, or sessions had to be scheduled at different times to accommodate the daily schedule. Schreibman (1988) suggested that for children with autism, an established routine is essential to skill development. With changes in teachers, teacher assistants, and time occurring frequently, it is possible that participant performance was affected adversely.

The number of communication opportunities within training sessions was a third limitation. On average, participants received only 22 communication opportunities during each sign language and PECS training session. Sundberg and Partington (1998) recommended "thousands of contrived training trials before verbal behavior occurs unprompted or spontaneously" (p. 129), while Bondy and Frost (2002) recommended at least 30 to 40 opportunities per session or day for initial PECS training. Increasing the number of communication opportunities to their recommended levels, or exceeding them, may have improved participants' acquisition of picture exchange and sign language.

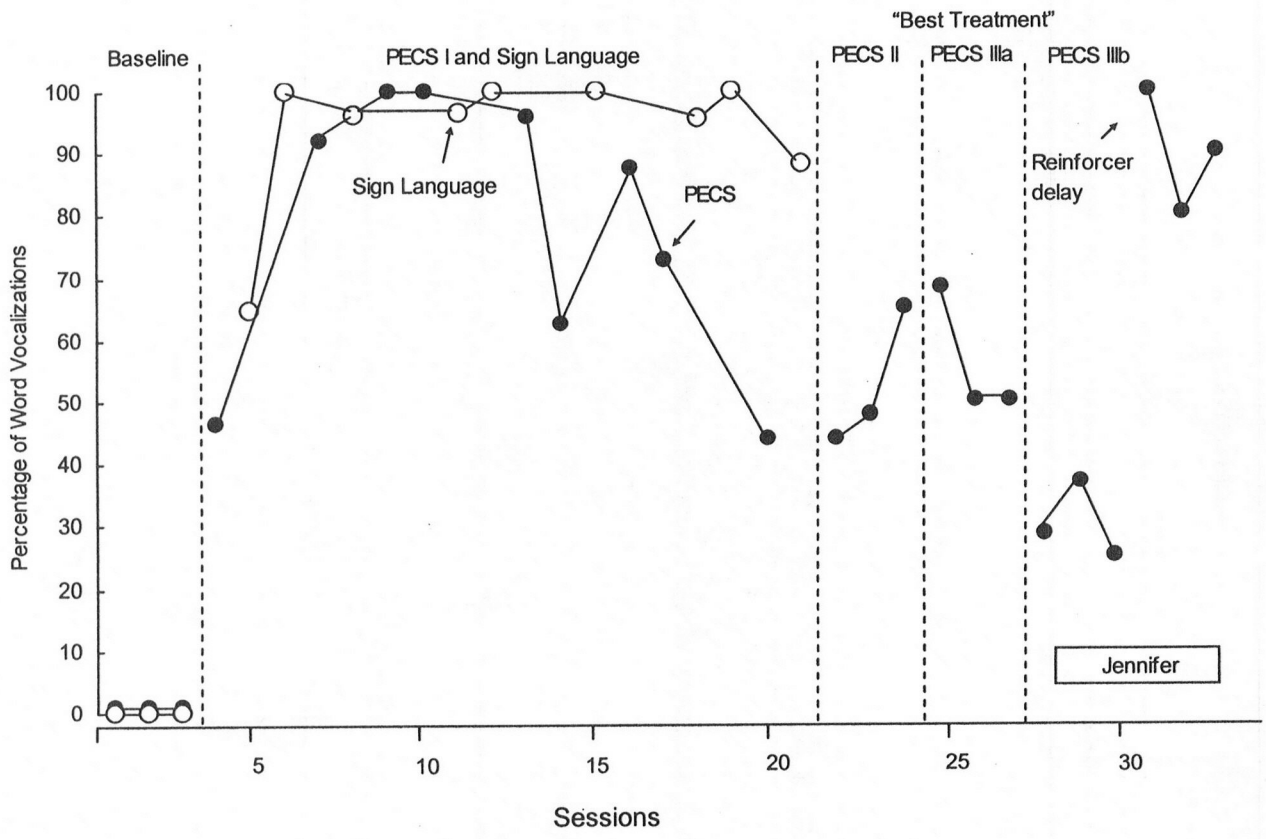

FIGURE 6. Percentage of word vocalizations in baseline and training conditions for Jennifer.

The results of this study suggest several areas for future research relating to fluency, instructional efficiency, and speech development. Although Bondy and Frost (2002) advised at least 30 to 40 picture exchanges per day, they make no specific recommendations about the rate of response necessary to establish fluency with PECS. Sundberg and Partington (1998) also did not make specific recommendations with respect to fluency and sign language. Behavioral fluency may be defined as "the fluid combination of accuracy plus speed that characterizes competent performance" (Binder, 1993, p. 164). Learners whose behavior is fluent may be more likely to maintain what they have learned and apply it in new situations. Maintenance and generalization may, therefore, be enhanced by increasing the learner's rate of hand signs and picture exchanges. Future research could address the optimal rates of response necessary to establish fluency with PECS and sign language. Instructional efficiency (e.g., Wolery & Gast, 1984) is a related area for future research. An efficient teaching procedure produces a desired learning outcome in as little instructional time as possible. In the current study, the exact duration of PECS and sign language training sessions was not recorded; therefore, conclusions about which procedure was more efficient cannot be drawn. As a comparison of instructional efficiency, future research could compare the amount of instructional time necessary to generate a mand repertoire with PECS versus sign language training.

The current study raised questions about speech development and PECS. For Jennifer, speech developed with PECS training appeared to decline until modifications were made to her training protocol. Specifically, reinforcement for picture exchanges was delayed by up to 4 s until she emitted a word vocalization. The procedure was implemented for only three sessions; therefore, the long-term effects of delaying reinforcement on picture exchanges and vocal speech are not known. Indeed, Bondy and Frost (2002) cautioned against requiring students to speak as they exchange picture symbols:

> We teach students to use PECS in order to teach them functional communication skills. . . . Therefore, we do not teach PECS as a way to learn to speak; we teach PECS as a way to learn to communicate. . . . The acquisition of speech can be viewed as a wonderful byproduct of the approach and not its direct focus. (p. 176)

Still, procedural modifications to the system might enhance speech development without hindering functional communication. Future research could examine the long-term usefulness of the reinforcement delay procedure used in this study, or other modifications to stimulus presentation, prompting, and error correction procedures as ways to enhance speech production.

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