Journal of Autism and Developmental Disorders, Vol. 34, No. 4, August 2004 (© 2004)

Effects on Communicative Requesting and Speech Development of the Picture Exchange Communication System in Children With Characteristics of Autism

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Few studies on augmentative and alternative communication (AAC) systems have addressed the potential for such systems to impact word utterances in children with autism spectrum disorders (ASD). The Picture Exchange Communication System (PECS) is an AAC system designed specifically to minimize difficulties with communication skills experienced by individuals with ASD. The current study examined the role of PECS in improving the number of words spoken, increasing the complexity and length of phrases, and decreasing the nonword vocalizations of three young children with ASD and developmental delays (DD) with related characteristics. Participants were taught Phases 1–4 of PECS (i.e., picture exchange, increased distance, picture discrimination, and sentence construction). The results indicated that PECS was mastered rapidly by the participants and word utterances increased in number of words and complexity of grammar.

KEY WORDS: Autism; augmentative and alternative communication; developmental diabilities; speech; communication; Picture Exchange Communication System (PECS)

INTRODUCTION

Augmentative and alternative communication (AAC) systems (i.e., systems used by persons with disabilities to replace or supplement insufficient communication skills) are widely used to assist with communication deficits of individuals diagnosed with autism spectrum disorders (ASD) and related disabilities (Mirenda, 2001; Mirenda & Erickson, 2000; Schuler, Prizant, & Wetherby, 1997). While both unaided (e.g., sign language) and aided (e.g., picture-based) AAC systems have been investigated for their utility with individuals with ASD, there remains debate concerning which techniques are most effective and practical.

Unaided AAC systems are those that require no external equipment (Bondy & Frost, 2002; Mirenda & Erickson, 2000). Several studies have demonstrated the ability of nonverbal individuals with ASD to learn to use more than 20 signs (Barrera, Lobato-Barrera, & Sulzer-Azaroff, 1980; Benaroya *et al.*, 1977, 1979; Bonvillian & Nelson, 1976, 1978; Fulwiler & Fouts, 1976; Stull *et al.*, 1980). Other researchers have reported that individuals with ASD were able to understand and use only 10 or fewer signs (Brady & Smouse, 1978; Carr, Binkoff, Kologinsky, & Eddy, 1978; Churchill, 1972, 1978; Webster, McPherson, Sloman, Evans, & Kuchar, 1973). Investigators have compared verbal and manual sign techniques implemented with individuals with ASD, finding that

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0162-3257/04/0800-0395/0

poor verbal imitators did well in conditions involving manual signs or signs and speech, but not speech alone (Layton, 1988); and that poor verbal imitators acquired only receptive sign language abilities (Carr & Dores, 1981). Perhaps, in part, due to the dearth of strong empirical support for the use of unaided AAC systems, such as sign language, many individuals with autism currently use aided, picture-based systems (Schuler *et al*., 1997) that require external equipment (Bondy & Frost, 2002; Mirenda & Erickson, 2000). Indeed, several studies have demonstrated the successful use of such systems with individuals with ASD (Sigafoos, 1998), many in naturalistic setting (Hamilton & Snell, 1993; Stiebel, 1999), and with adolescents and adults (Reichle & Brown, 1986; Rotholz, Berkowitz, & Burberry, 1989; Vaughn & Horner, 1995).

Presently, aided, picture-based AAC systems are used more frequently and successfully with individuals with ASD than unaided systems, due to a match between the characteristics of ASD and the ease of use of such systems (Mirenda & Erickson, 2000; Schuler & Baldwin, 1981). Several early studies found that difficulties in imitation may be one reason manual signs are difficult for people with ASD to use and understand (Carr & Dores, 1981; Carr, Pridal, & Dores, 1984; Layton, 1988; Mirenda & Erickson, 2000; Yoder & Layton, 1988). Fine motor problems also contribute to difficulty for individuals with ASD to learn manual signs (Hughes, 1996; Jones & Prior, 1985; Mirenda & Erickson, 2000; Seal & Bonvillian, 1997). However, picture symbols, which typically provide two-dimensional representations resembling their referents may be easier for some children with ASD to learn than manual sign symbols, only some of which resemble the referents they represent. In this connection, picture-based communication systems are preferred over manual sign systems because they are more easily understood by members in the community who are not trained to use the systems (Mirenda & Erickson, 2000; Rotholz *et al*., 1989).

The Picture Exchange Communication System (PECS), the system used in this study, is an aided, picture-based AAC system frequently used with individuals with ASD (Mirenda, 2001; Mirenda & Erickson, 2000). PECS is based on several key concepts regarding individuals with ASD and how they learn language and social interaction skills (Bondy & Frost, 1994, 1998, 2001). First, while many traditional speech programs (i.e., speech, sign language) require that students first attain attending skills (e.g., eye contact, ''get ready'' position), PECS reportedly does not typically require weeks or months of formal training in such prerequisites (Bondy & Frost, 1998). In addition, traditional speech training often begins by teaching students to respond to verbal prompts (e.g., ''point to the dog,'' ''touch the spoon''), whereas PECS instruction begins by teaching a social approach to another individual, a key deficit in ASD. Though many communication techniques begin by teaching children to label, Bondy and Frost (2001) assert that requesting should be taught to children with ASD first, as required by PECS protocol, because it is rewarded and maintained by concrete reinforcement (e.g., food, toys). Social reinforcement (e.g., verbal praise), however, is not motivating for many individuals with ASD.

In spite of its logical design and foundation in applied behavior analysis, support for PECS is primarily anecdotal in nature (Mirenda & Erickson, 2000). That is, few published, experimental studies have specifically addressed the efficacy of PECS when used with children with ASD and other developmental disabilities. Bondy and Frost (1994) provided group outcomes on young students trained in PECS at a statewide autism program and found that seven of 26 preschool students acquired the use of ten pictures to make requests in an average of three months, and 85 children who entered the program with no functional speech learned to exchange at least one picture within the first month of training. Bondy and Frost (1998) also reported that a boy who began PECS at age 2 years, 8 months, began speaking after using PECS for 11 months, eventually replacing PECS with speech 18 months after implementation. Schwartz, Garfinkle, and Bauer (1998) described 31 children with a variety of disabilities, including ASD, who used PECS in an integrated preschool program and mastered the system through Phase 4 (sentence construction) with adults and peers within an average of 14 months. PECS was also used with a four-year-old boy with autism to decrease aggressive behavior in a general education preschool classroom (Frea, Arnold, & Vittimberga, 2001). Recently, Charlop-Christy, Carpenter, Le, LeBlanc, and Kelle (2002) reported positive effects regarding mastery of PECS, problem behaviors (e.g., tantrums, out of seat behavior), and social-communicative skills as a result of PECS training with three children with autism between the ages of 3 and 12. Research presented at professional conferences

provides additional support for PECS for use with individuals with ASD, including rapid acquisition of picture vocabulary (Charlop-Christy, 2001; Overcash, Bondy, & Harris, 1996; Schwartz, 2001), reduction of problem behaviors (Charlop-Christy, 2001; Overcash *et al.*, 1996), implementation of PECS with adults over 37 years of age (Helsinger, 2001), and use of PECS with peers (Schwartz, 2001).

In addition to evidence demonstrating the abilities of individuals with ASD to learn to utilize picture-based, aided AAC systems, a few studies address the use of such systems to encourage speech (Mirenda & Erickson, 2000). Romski and Sevcik (1996) conducted a research project, with two children with autism, wherein the participants were exposed to voice-output communication aids (VOCAs) with abstract graphics and written words, resulting in increased spoken-word vocabularies. Seven children with no speech or functional communication skills began PECS training at a mean age of 3 years, 6 months (Bondy, 1989) and began speaking within a mean of 5.4 months. Moreover, Frost and Bondy (1994) reported that of 26 preschoolers with ASD, seven of the children developed speech to the degree that they were no longer recognized as having autism. After 5 years of using PECS, 52% of 66 children acquired functional speech and no longer needed an AAC system, and another 21% acquired some speech that they used in combination with PECS (Bondy & Frost, 1995). An investigation by Schwartz, *et al.* (1998) studied 18 students, 11 of whom had ASD, discovering that students who demonstrated five or more verbal words at the beginning of training showed growth in speech during naturalistic observations; however, children with fewer than five verbal words at the beginning of training showed little or no speech growth. Nineteen preschool children with autism who attended a statewide program for children with autism and used PECS for under a year were described by Bondy and Frost (1994). Five learned to speak with support of PECS and two began speaking independently of the use of PECS. Most recently, Charlop-Christy *et al.* (2002) reported increased spontaneous and imitative speech as a result of PECS training. All three children included in their study considerably increased imitative and spontaneous speech, as well as mean length of utterance, as a result of PECS training.

Despite the limited, published empirical data on the efficacy of PECS with individuals with ASD, it enjoys wide utilization in schools (Mirenda & Erickson, 2000). Moreover, PECS enjoys a reputation for stimulating speech (Mirenda & Erickson, 2000). In this regard, there is a need for additional research to support the use and utility of PECS in promoting word utterances and functional communication skills in children with ASD. The current study, involving students with ASD and autism-like characteristics, was designed to evaluate the utility of PECS to increase the number of words spoken and complexity of word utterances in one child with autism and two with developmental disabilities with autistic characteristics. The effectiveness of PECS was specifically evaluated in relation to its capacity to (a) increase students' proficiency in learning to use a functional communication system, (b) increase the number of words used in making verbal requests, (c) increase the complexity of utterances, and (d) decrease non-word vocalizations.

METHOD

Participants and Setting

Sampling Procedures

Three students (one preschool and two elementary age), with autism spectrum disorders (ASD) (American Psychiatric Association, 2000) and developmental delays (DD) who also had characteristics of autism were recruited for participation in this study. These diagnoses had been given, independently of the current research, by various professional, including educators, psychologists, psychiatrists, and other medical doctors. The participants were identified by local school district personnel and parents as having little to no functional speech (i.e., zero to ten spoken words used in functional contexts). Each of the participants also met the following criteria: (a) no prior experience with the PECS or exposure to PECS, including observing others using PECS, (b) between the ages of three and seven years of age, (c) preverbal or limited functional speech, and (d) in need of an AAC system.

Participant 1: Gail

Participant 1 was an Asian female, 5 years and 8 months of age, who was identified by a district school psychologist and educational team as having severe autism. Table I provides additional demographic, diagnostic, and educational information. According to teacher and parent report, as well as Gail's Individualized Education Program (IEP), she

Table I. Participant Descriptions

Participant	Gail	Ramon	Ben
Age	5 years, 8 months	7 years, 2 months	3 years, 9 months
Gender	F	M	M
Race	Asian	African-American	Caucasian
Diagnosis & Relevant diagnostic measures	AU *CARS* score of 37.5 (severe AU)	DD with autistic characteristics & SLI; *CARS* score of 30.5 (mild-moderate AU)	DD & SLI; *CARS* score of 50.5 (severe AU)
Current assessments	*Vineland* Percentile <0.1 AE = 0 years, 7 months	No current assessments	*Battelle* Percentile = 2 AE = 26 months
School placement	Half-day general education kindergarten	General education first grade class, 120 months of SPED, 60 months of SLT/week	Half-day early childhood SPED setting 4 days/week, 60 months SLT, 10 months social work/week

AU: Autism; DD: Developmental Delay; SLT: Speech/Language Therapy; SLI: Speech/Language Impairment; SPED: Special Education Services; AE: Age Equivalency.

could say, "bye bye," "goodbye," "come on," "oh no," her first name, could rote count to 10, and used limited immediate and delayed echolalia. The teacher reported that she did not consistently use these words functionally (i.e., in the appropriate context). Additionally, she did not respond to her name, label items, follow one-step directions, or interact with peers. Gail's parents had immigrated to the United States and spoke two languages; however, she did not speak her parents' native language.

Participant 2: Ramon

Participant 2 was an African-American male, 7 years and 2 months of age, who was identified by a district school psychologist and educational team as having DD with autistic characteristics and speech language impairment. Table I provides additional demographic, diagnostic, and educational information. According to his current IEP and teacher, speech language pathologist, and paraprofessional report, Ramon could say over 30 words (e.g., names of teachers and classmates), but infrequently did so in a spontaneous, functional context, had limited vocabulary and general knowledge, repeated "wh-" questions when asked (instead of answering them), rarely initiated greetings or requests, and used immediate echolalia, but rarely in a functional context.

Participant 3: Ben

Participant 3 was a Caucasian male, 3 years and 9 months of age, who was identified by a district school psychologist and educational team as having DD and speech language impairment. Table I provides additional demographic, diagnostic, and educational information. According to his current IEP and teacher report, Ben could say over 20 words (e.g., colors, numbers, letters, states, names of his classmates), but inconsistently used them spontaneously and functionally, would infrequently correctly answer questions, frequently repeated questions instead of answering them, needed several repetitions to follow single-step directions, persevered on naming colors, used jargon, and displayed immediate and delayed echolalia (e.g., sing songs by rote). Additionally, he would not use or imitate greetings with the principle investigator without visual support (i.e., written word and line drawing).

Settings

This study was conducted in each participant's elementary school classroom, located in low socioeconomic neighborhoods in a large, urban school district. Consistent with best practice literature PECS training took place in natural school settings (i.e., homeroom classrooms) in order to promote skill generalization (Koegel, 2000).

Procedures

Prior to PECS training, parents, teachers, and paraprofessionals were asked to complete a checklist of preferred reinforcements for each participant. They were also asked to provide a list of words each child had been observed to say. Training followed the procedures outlined by Frost and Bondy

Table II. Phases of PECS Implemented in this Research and as Described by Frost and Bondy (2001)

Phase	Description
Reinforcer assessment	Informally offering the student a number of items or foods to determine which are most highly preferred.
1: Basic picture exchange	Each participant was taught to approach an adult, give him or her a picture, and receive a preferred item. Over several exchanges, physical and gestural assistance was faded. Two trainers were used in this phase, as required in the PECS manual.
2: Increasing distance	Participants were taught to retrieve a picture from their communication binders, which had been moved away from them, walk to a communicative partner, and persist in handing the picture to the communicative partner, who had moved across the room. Two trainers were used in this phase.
3: Picture discrimination	First, two items, one preferred by the participant and one non-preferred, were presented to the participant and corresponding pictures were placed on the front of the communication binder. Error correction procedures were incorporated to ensure mastery. At the end of Phase 3, participants were able to choose from six or more preferred and non-preferred items.
4: Sentences	Utilizing backward chaining, participants learned to take a sentence starter (i.e., "I want" picture) from the communication book, place it on a sentence strip (i.e., 2 in. × 4 in. plastic strip with Velcro® attached), place the preferred item's picture on the strip, and exchange the whole strip. During each exchange, the communicative partner modeled a complete verbal sentence; however, the child received the item upon exchanging the pictures, regardless of whether or not he or she read the sentence.

(1994) in the PECS[4], which provides instructions for each training phase, descriptions of appropriate materials, and mastery criteria of each phase. Table II provides a brief description of each phase of PECS as implemented in this study.

During the current research, two to five PECS training sessions took place per week (dependent on school holidays and student attendance), for 15 trials per session, until participants' mastered the first four phases of PECS. Mastery criteria was 80% of the trials performed independently for three consecutive 15 trial sessions, for each phase, in accordance with the criteria outlined in the *Picture Exchange Communication Manual* (Frost & Bondy, 1994). Each phase was continued for a minimum of five sessions, even if the child met mastery criteria in three sessions, to ensure adequate practice in each phase.

Design

This research study used a single-subject design within subjects. The design of the current research most closely aligned with use of a changing criterion design (Kazdin, 1982), in that such a design eliminates the necessity of withdrawing the intervention, and includes several intervention sub-phases. While the criterion for advancing to the next phase of PECS remained consistent (i.e., students must show proficiency in the phase at 80% or greater for three consecutive phases, including a minimum of five sessions per phase), the criteria for demonstrating proficiency (i.e., the amount of effort participants were required to make) in a phase were increasingly more difficult. While it may be considered a weakness that this study lacked baseline data, the authors chose the current methodology because it adhered strictly to the PECS protocol (Frost & Bondy, 1994).

Independent Variables

Independent variables were held constant during PECS training. They include trainer modeling of verbalizations (e.g., "I want bubbles") and training guidelines for each phase, per the PECS protocol, as described above (Frost & Bondy, 1994).

Outcome Variables

Three outcome variables were measured during PECS training sessions. First, observers collected data on each participant's proficiency relative to the PECS phase criteria, recording whether the child performed the desired response independently (score of 1) or with prompting (score of 0, any verbal, gestural, physical, or corrective assistance given to facilitate the exchange) for each trial, defined as beginning when the communicative partner began enticing the child with a preferred item(s) or when the child spontaneously took a picture out of the communication book to make a request, and ending 5 seconds after the participant completed the exchange. The observers also recorded the number of intelligible words

[4] A more current manual has been published since this investigation took place: Frost, L., & Bondy, A. (2002). PECS: *The Picture Exchange Communication System Training Manual* (2nd ed.). Cherry Hill, NJ: Pyramid Educational Consultants.

Table III. Participants' Time to Mastery of PECS for each Phase

	Participant 1: Gail	Participant 2: Ramon	Participant 3: Ben	Averages
Phase 1	7 Sessions (108 trials)	5 Sessions (75 trials)	5 Sessions (74 trials)	5.7 Sessions (86 trials)
Phase 2	5 Sessions (76 trials)	5 Sessions (71 trials)	5 Sessions (75 trials)	5 Sessions (74 trials)
Phase 3	12 Sessions (184 trials)	5 Sessions (76 trials)	5 Sessions (76 trials)	7.3 Sessions (112 trials)
Phase 4	5 Sessions (79 trials)	5 Sessions (70 trials)	5 Sessions (75 trials)	5 Sessions (75 trials)
All four phases	29 Sessions (447 trials)	20 Sessions (292 trials)	20 Sessions (300 trials)	23 Sessions (346 trials)

spoken and the presence (1 = yes, 0 = no) of non-word vocalizations (i.e., any vocalization that the observers could not recognize as an intelligible word) per trial. In addition to numerical data, videotapes were observed to collect samples of speech occurring during trials, as previously defined, during the first and last sessions of each phase (Tables IV–VI), to provide evidence of the participants' use of grammar and syntax, and demonstrate the variety of vocabulary used by participants. PECS training was videotaped for data collection purposes, so that data, as well as anecdotal information, could be collected at every training session. It should be noted that the speech samples are only representative of spoken language emitted during PECS instruction, thus these samples are not examples of speech generalized outside of PECS usage.

Materials

Materials used in PECS training included communication binders, approximately $8'' \times 6''$. The front and inside covers of each binder had strips of Velcro®. The binders also had pages inserted with strips of Velcro® on both sides, as well as a $2'' \times 4''$ plastic "sentence strip" with Velcro® on each side. Each participant also had a minimum of 20 color line drawings ($1.75'' \times 1.75''$) and color photos ($1'' \times 1.75''$) from an instant camera by the end of training. Each picture had Velcro® on the back and was stored in the participants' communication binders. Other materials were determined by participants' preferences as detailed previously.

RESULTS

Reliability

Three independent graduate students assisted in data collection, as described above. Observer agreement was calculated using a point-by-point agreement ratio, by dividing the number of agreements by the total number of agreements plus disagreements, multiplied by 100 (Kazdin, 1982). An agreement occurred when all observers independently recorded the same score on an item. When inter-observer agreement fell below 80% during observation of PECS training tapes, retraining was undertaken (i.e., observing tapes again, discussing

Table IV. Speech Samples in each Training Phase for Participant 1

	Speech samples	Perceived communicative function
Phase 1		
First session	–	
Last session	"Stop!"	Protest
	"M&M"	Request
Phase 2		
First session	"Zebra, zebra."	Request for wind-up zebra
	"Oh, zebra. Zebra!"	Request
Last session	"Oh, no, oh no. No, no, no. Wait! Wait!"	Protest in response to investigator taking item away
Phase 3		
First session	"Skittle"	Request
Last session	"Sit down. Down."	Echo investigator's direction
	"No! Wait."	Protest in response to investigator taking picture away
Phase 4		
First session	"No!"	Protest in response to investigator taking item away
	"I."	Request for Skittles
Last session	"I want loo."	Request for fruit loops
	"I want . . . I want froo loo."	Request
	"I want marmer."	Request for markers
	"I . . . I want . . . froo loo. . . Skittle."	Request

– Indicates no recognizable speech in that session.

Table V. Speech Samples in each Training Phase for Participant 2

	Speech samples	Perceived communicative function
Phase 1		
First session	–	
Last session	"Toy car."	Request
	"Balloon."	Request
Phase 2		
First session	"Here."	Request for investigator to take the picture, said as handing picture of ball
	"Toy car. Buzz toy."	Give information, in response to paraprofessional's question, "What is it?"
Last session	–	
Phase 3		
First session	"Candy."	Comment on what investigator had – refused when offered, thus not a request
	"Sock."	Request
	"Ball."	Request
Last session	"Toy car."	Request
	"Sock."	Request
	"Play clay. Christmas tree."	Request, comment on what he was making
	"Buzz toys."	Request
	"Game."	Request
	"I can see."	Comment
	"Marker."	Request
	"All done."	Comment
	"Color."	Request for marker
Phase 4		
First session	"I want snap blocks."	Request
	"I want game. I want game. I want game."	Request
	"I want play clay. I want play clay."	Request
	"I want . . . I want marker . . . I want."	Request
	"I want sticker."	Request
Last session	"I want game."	Request
	"I want toy car."	Request
	"I want buzz toy."	Request
	"I want play clay."	Request
	"I want balloon. White."	Request for balloon, including attribute ("white")

– Indicates no recognizable speech in that session.

points of disagreement, then observing additional tapes). Inter-observer agreement was assessed on approximately 40% of all sessions of PECS training. Sessions were randomly selected to be observed by a secondary observer (38% of Gail's sessions and 40% of Ramon's and Ben's sessions). The overall mean inter-observer coefficient of agreement was calculated at 93% for Gail, 94% for Ramon, and 92% for Ben. Coefficients of agreement broken down by categories of behavior observed are available from the first author.

Analysis of Data

Single-subject methods were used to analyze the data and answer the research questions. Data were plotted graphically to determine if the data show a causal relationship between the intervention (i.e., PECS) and improvement in number of words spoken per trial and trends were examined to determine results.

Participant 1: Gail. The results for Gail are provided in Fig. 1 and Table IV. Data regarding Gail's proficiency in PECS phases (Table III, Fig. 1, top panel) demonstrates that she mastered the system in 29 sessions (447 trials). Phase 1 was mastered in 108 trials (seven sessions), Phase 2 in 76 trials (five sessions), Phase 3 in 184 trials (12 sessions), and Phase 4 in 79 trials (five sessions). She took longer than the other two participants to master Phases 1 and 3, continuing Phase 3 for three sessions each for two pictures, three pictures, four

Table VI. Speech Samples in Each Training Phase for Participant 3

	Speech samples	Perceived communicative function
Phase 1		
First session	"Lilly Pooh."	Request for Winnie the Pooh toy
	"Orange."	Request for marker, including attribute ("orange")
	"(Mumble) black."	Request, including attribute
	"Tigger."	Request
Last session	"Marker."	Request
	"Balloon."	Request
	"Puzzle . . . puzzle pieces"	Request
Phase 2		
First session	"Puzzles."	Request
	"Bus."	Request
Last session	"A zero."	Comment on a puzzle piece
	"Bus."	Request
	"Puzzle pieces."	Request
	"Got circle? Circle."	Request for circular train piece
Phase 3		
First session	"Bus."	Request
	"M . . . orange . . . Y."	Request, including attribute, for different colored beads with letters on them
	"Beads."	Request
	"O . . . the letter O."	Comment on bead he received
Last session	"It's game."	Request for hand-held game
	"Y."	Comment on the letter on the bead he received
	"Find the letter K."	Request for the letter K bead
	"Letter d beads."	Request
	"Blocks."	Request
Phase 4		
First session	"Want beads."	Request
	"I want beads."	Request
	"I . . . markers."	Request
	"I want markers."	Request
	"Letter T . . . I want markers. Yellow. Letter T."	Request, comment on what he was writing, including attribute
	"I want cars."	Request
Last session	"Book . . . I want . . . I want book."	Request
	"Lello. I want markers. That's markers. I want markers."	Request, comment, including attribute ("yellow")
	"I wan nanana. I want animals."	Request

– Indicates no recognizable speech in that session.

pictures, and six pictures, to gradually teach her to discriminate between more pictures.

The middle panel of Fig. 1 provides Gail's data on average words per trial. Graphical data attests to a clear pattern with few outliers. Gail demonstrated few words per trial in Phase 1, averaging 0.36 words (range = 0–0.93, $SD = 0.29$). She spoke slightly more in Phase 2, on average, saying 0.65 words per trial (range = 0.27–1.73, $SD = 0.61$). This dropped even lower in Phase 3, to 0.13 words per trial (range = 0–0.40, $SD = 0.12$). However, she showed dramatic growth during Phase 4, using an average of approximately three-word phrases in each trial ($M = 2.70$, range = 0.30–5.10, $SD = 1.79$).

Table IV provides examples of Gail's speech during the first and last session of each phase of PECS training. This reveals her progress from no recognizable speech at the beginning of training, to a far larger quantity of speech by Phase 4. Moreover, though she increased her mean words per trial in Phase 2, she frequently demonstrated protests (e.g., "No," "Wait!"). In contrast, by the end of Phase 4, she demonstrated more desirable speech in the form of requests (e.g., "I want marmers [markers]").

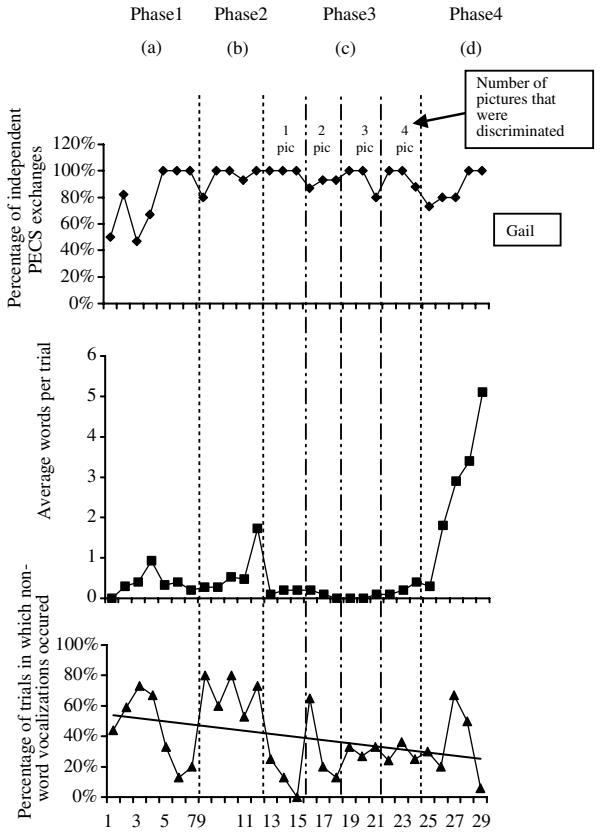

Fig. 1. PECS Proficiency (top panel), words per trial (middle panel), and non-word utterances (bottom panel) for participant 1, Gail.

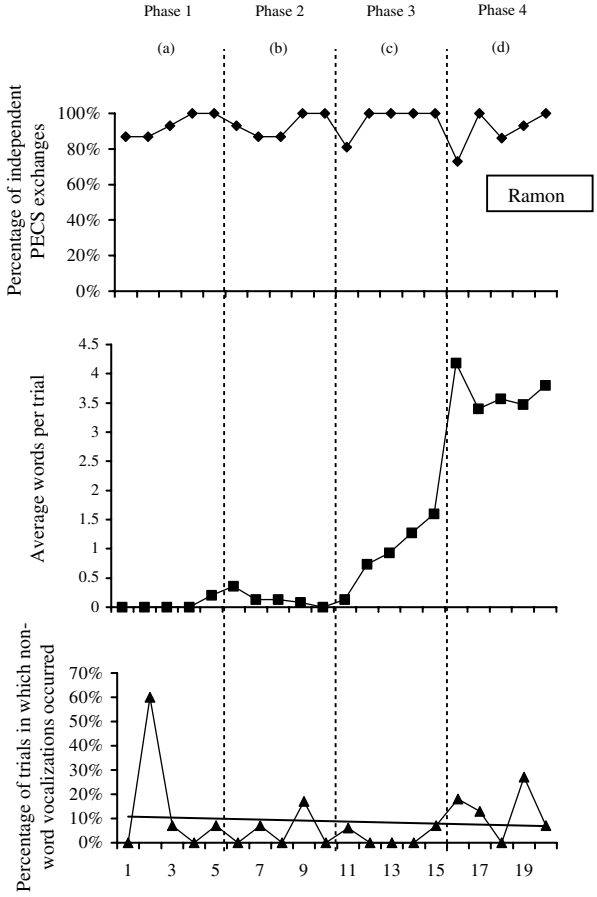

Fig. 2. PECS Proficiency (top panel), words per trial (middle panel), and non-word utterances (bottom panel) for participant 2, Ramon.

Data for percentage of trials in which non-word vocalizations occurred (Fig. 1, bottom panel) does not display a clear visual pattern. The aggregate trend line reveals a decrease; however, visual inspection of the data demonstrates great variability and means across the phases were not consistent (Phase 1: $M = 44\%$ of trials, range = 13%–73%; Phase 2: $M = 69\%$, range = 53%–80%; Phase 3: $M = 26\%$, range = 0%–65%; Phase 4: $M = 35\%$, range = 6%–67%). Thus, Gail's data suggests that while intelligible word utterances increased throughout PECS training, graphical data on non-word vocalizations does not reveal a directly inverse relationship (i.e., as average words per trial increase, non-word vocalizations do not decrease).

Participant 2: Ramon

Fig. 2 and Table V show the results for Ramon. He demonstrated mastery of PECS (Table III, Fig. 2, top panel) within 20 sessions (292 trials). He mastered Phase 1 in 75 trials (five sessions), Phase 2 in 71 trials (five sessions), Phase 3 in 76 trials (five sessions), and Phase 4 in 70 trials (five sessions). Additionally, Ramon began scanning through his communication binder in Phase 1 and selecting pictures for items he saw the investigator display, prior to Phase 3, discrimination training. Unlike Gail, Ramon demonstrated the ability to discriminate during Phase 1, by opening his communication binder spontaneously and selecting pictures for items he wanted, including over 20 pictures distributed throughout several pages in their binders.

The middle panel of Fig. 2 presents data on Ramon's average intelligible words spoken per trial. Ramon displayed very little growth in average words per trial throughout the first two phases of

PECS (Phase 1, $M = 0.04$, range = 0–0.2, $SD = 0.09$; Phase 2, $M = 0.14$, range = 0–0.36, $SD = 0.13$). However, he demonstrated substantial increases during Phases 3 ($M = 0.93$, range = 0.13–1.27, $SD = 0.56$) and 4 ($M = 3.68$, range = 3.40–4.18, $SD = 0.32$).

Table V presents samples of Ramon's speech in the first and last sessions of each phase of PECS training. Ramon displayed one- and two-word utterances throughout the first three phases of training, though far more frequently in Phase 3, discrimination training. In Phase 4, he began speaking most often in three- to four-word phrases, though his speech was more repetitive at the beginning of the phase and more typical by the end of the phase. although graphical data (Fig. 2, middle panel) illustrates more word utterances in the first session of Phase 4 (session 16) than in the last session (session 20), speech samples suggest that the higher average at the beginning of Phase 4 was due to multiple repetitions of sentences or parts of sentences.

Overall, Ramon demonstrated lower percentages of trials in which non-word vocalizations occurred (Figure 2, bottom panel) than the other participants. Similar to the other two participants, Ramon's data demonstrates high variability. Percentages of non-word vocalizations across the phases do not show significant change throughout PECS training (Phase 1: $M = 15\%$ of trials, range = 0%–60%; Phase 2: $M = 5\%$, range = 0%–17%; Phase 3: $M = 3\%$, range = 0%–7%; Phase 4: $M = 13\%$, range = 0%–27%). Again, there is no clear relationship between words per trial and non-word vocalizations. Ramon underwent oral surgery between sessions 16 and 17 and missed one week of school. Surprisingly, this did not appear to negatively impact his speech production or intelligibility.

Participant 3: Ben

Ben's results are shown in Fig. 3 and Table VI. Data regarding Ben's proficiency in PECS phases (Table III, Fig. 3, top panel) demonstrates that he mastered the system in 20 sessions (300 trials). Phase 1 was mastered in 74 trials (five sessions), Phase 2 in 75 trials (five sessions), Phase 3 in 76 trials (five sessions), and Phase 4 in 75 trials (five sessions). Moreover, in Phase 1, Ben began browsing through his communication binder and choosing pictures for items he preferred, in advance of Phase

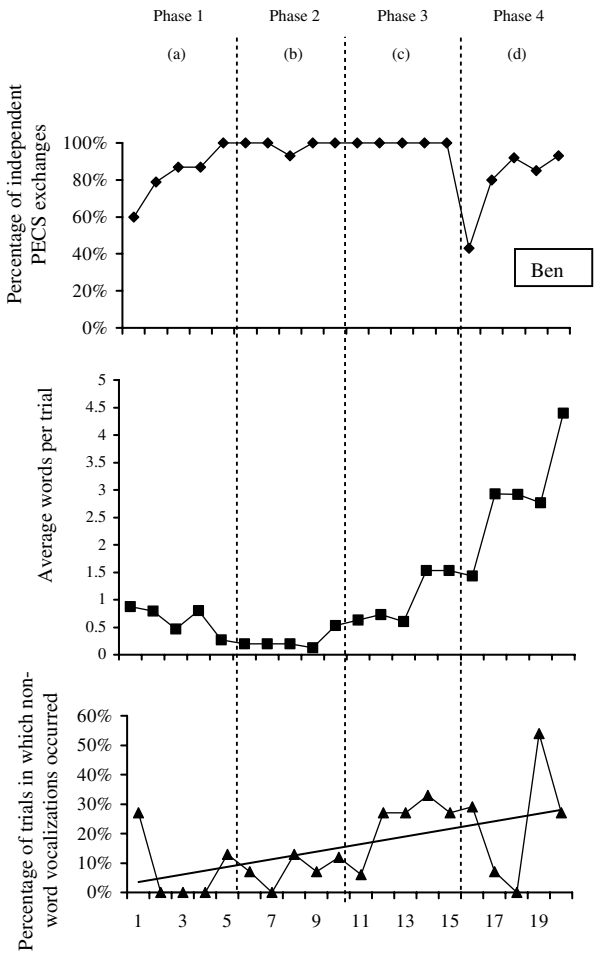

Fig. 3. PECS Proficiency (top panel), words per trial (middle panel), and non-word utterances (bottom panel) for participant 3, Ben.

3, discrimination training. In all phases, he displayed mastery of the system with a variety of adults. This included making spontaneous, unprompted picture requests to all the adults in his classroom, outside of PECS training sessions, as reported to the primary investigator at session 7, Phase 2. While formal generalization data were not collected, these anecdotal reports provided some evidence of generalization. His mother participated in training in session 10, Phase 2, during which Ben easily generalized communication skills to her, noticing when she had his preferred items and initiating exchanges with her. During Phase 3, session 13, Ben began requesting items that he preferred (beads) that were not in his visual field. In Phase 4, Ben demonstrated the ability to self-correct when he

put the sentence strip together, changing pictures of the preferred items. For example, during session 20, he constructed a sentence strip, including a book picture, handed it to the primary investigator, read it as, "I want markers," and removed the book picture and replaced it with the markers picture.

Figure 3, middle panel, presents Ben's average words per trial. Ben demonstrated low average words per trial throughout the first two phases of PECS (Phase 1, $M = 0.64$, range = 0.27–0.87, $SD = 0.26$; Phase 2, $M = 0.25$, range = 0.13–0.53, $SD = 0.16$). However, he showed growth during Phases 3 ($M = 1.00$, range = 0.60–1.53, $SD = 0.48$) and 4 ($M = 2.89$, range = 1.43–4.40, $SD = 1.05$). Table VI reports samples of Ben's speech during the first and last sessions of each phase. Ben's speech, during the first three phases of PECS training, consisted mainly of single-word utterances. During the first phase of training, Ben infrequently said the name of the picture he was exchanging; however, he began to do so in Phase 2 and did so frequently in Phase 3. In Phase 4, he quickly learned to read back complete sentences from the sentence strip. Throughout training, Ben included attributes (e.g., color, shape), and his teacher reported that, at lunch during Phase 4, he asked for items by number (e.g., "I want 10 cookies").

Figure 3, bottom panel, displays Ben's data on percentage of trials in which non-word vocalizations occurred. The trend line for Ben's non-word vocalizations shows an increase. However, a visual inspection of the data demonstrates great variability and means across the phases were inconsistent, and did not show a clear pattern (Phase 1: $M = 8\%$ of trials, range = 0%–27%; Phase 2: $M = 8\%$, range = 0%–13%; Phase 3: $M = 24\%$, range = 6%–33%; Phase 4: $M = 23\%$, range = 0%–54%). This increase in unintelligible vocalizations can be attributed to Ben's tendency to mumble; many of the non-word vocalizations were word approximations. However, as Ben used more intelligible word utterances as PECS training progressed, his word approximations improved.

DISCUSSION

An analysis of the data indicated that, as a result of PECS intervention, all three participants in the current research made progress in mastery of the PECS system and demonstrated increases in average intelligible words spoken per trial. Additionally, students showed generalization of skills with a variety of adults. Overall, the participants mastered the PECS program rapidly (Table III, Figs. 1–3, top panels), learning the system in an average of 23 sessions ($M = 346$ trials). Phase 1 was mastered in a mean of 5.7 sessions ($M = 86$ trials), Phase 2 in a mean of five sessions ($M = 74$ trials), Phase 3 in a mean of 7.3 sessions ($M = 112$ trials), and Phase 4 in a mean of five sessions (75 trials). At the completion of PECS intervention, all three participants were using high levels of words per trial, compared to their number of words during Phase 1 (Figs. 1–3, middle panels). Gail made great gains in Phase 4, while Ramon and Ben made gains in Phase 3, before considerable increases in Phase 4. In addition, complexity of sentences increased. All participants began Phase 1 without word utterances or speaking in one-word utterances and ended Phase 4 speaking in three- to four-word phrases (Tables II–IV, Figs. 1–3, middle panels). Furthermore, one of the participants, Ben, frequently used attributes and began spontaneously using PECS throughout the day with adults not participating in generalization training and during activities not targeted. The two other participants revealed skill generalization to additional activities and adults (e.g., teachers, speech language pathologists, paraprofessionals) who participated in PECS training. In accordance with these data, the current research supports the hypothesis that aided AAC systems, such as PECS, may be efficacious in encouraging speech in individuals with ASD.

Related to latency of mastery of the PECS system, all three participants rapidly mastered Phases 1–4 (Table III, Figs. 1–3, top panels). Indeed, participants mastered the phases more quickly than participants in previous research (Frea *et al.*, 2001; Schwartz, 2001; Schwartz, *et al.*, 1998) and showed rate of mastery slightly longer than that presented in other research (Charlop-Christy *et al.*, 2002). Each participant mastered the four phases in less than 2 months, taking an average of 23 sessions (346 trials). In previous research, three preschool children learned Phase 1 in an average of 2 months and mastered through Phase 4 in an average of 14 months (Schwartz, 2001). Preschool children in an integrated setting took, on average, 11 months to master Phases 1–4 (Schwartz *et al.*, 1998). Charlop-Christy *et al.*, (2002) reported mastery of all six phases of PECS within an average of 246 trials. Variations in latency of mastery of PECS may be

due to differences in individuals' cognitive levels (i.e., those with lower cognitive functioning and/or who are very young may take longer to learn PECS than those with higher cognitive functioning and/or who are older). Additionally, the ease with which most individuals with ASD learn PECS may be explained by a number factors: (a) inclusion of individuals' preferred items as motivation to initiate communication; (b) use of concrete visuals as opposed to transitory symbols such as manual signs; and (c) initial lessons focusing on requests, which are more motivating and rewarding to individuals with ASD than such communicative functions as comments (Bondy & Frost, 2001). It is plausible that the three participants in the current research acquired skills in communicating via PECS so rapidly due to the following characteristics and factors: (a) they began PECS training at or under the age of seven years; (b) preferences were determined for individual participants prior to PECS training, and were utilized to teach requesting skills; and (c) the symbols, color line drawings with written words, used in the program, were easily recognized by the participants.

The results of the current research demonstrated large gains in mean number of words per trial for all participants (Figs. 1–3, middle panels), particularly in Phases 3 and 4, though one participant, Gail, did not show an increase in word utterance until Phase 4, while the other two began increasing in Phase 3. Variations in latency to begin speaking and amount of intelligible word utterances could be the result of several factors. First, Ramon and Ben began PECS training with larger echolalic vocabularies (i.e., over 20 words apiece, while Gail said fewer than 10). Although they sporadically used speech in functional contexts, experience speaking may have contributed to the boys' production of intelligible word utterances sooner than Gail. Repeated modeling and speech practice inherent in PECS procedures gave the participants opportunities to utilize echolalia in functional contexts. Finally, in Gail's home, both parents spoke two languages, with English as their second language, which may have contributed to her difficulty learning to speak in English.

In addition to the increase in words per trial, each participant began using longer phrases and speaking with more complex syntax by the end of PECS training (Tables II–IV). It is likely that Ramon's and Ben's previous skills in naming objects by attribute (e.g., color, shape) contributed to their ability to incorporate adjectives into requests as PECS training advanced. While Gail may have been able to learn to include adjectives in making requests, this would likely require direct teaching. Because no prior literature provided in depth discussion of words per trial or complexity of syntax in relation to PECS, no direct comparison can be made to previous study participants. However, Charlop-Christy *et al.* (2002) did report increases in mean length of utterance for three children with autism in both academic and free play settings as a result of PECS training.

A point of speculation arising from the current research is the difficulty in determining what specific factors, elements, or combination of elements, of the intervention caused the changes in participants' skills. For example, it may have been possible that participants' word utterances would have increased by implementing only Phases 3 and 4 of PECS, since those are the phases in which word utterances increased. A variety of components of PECS may have been responsible for the changes. Delayed verbal modeling in Phase 4 occurred simultaneously with large increases in words per trial for all three participants, thus it may be the key element. Other factors that play a significant role in improvement of speech could include the slow, gradual introduction of parts of sentences, or the visual, concrete aspect of the pictures, as opposed to the transient nature of manual signs and gestures (Bondy & Frost, 2001).

It was hypothesized that as mean length of utterance increased, non-word vocalizations would change. This was discovered to be correct (Figs. 1–3, bottom panels), albeit it was anticipated that non-word vocalizations would decrease as the subject acquired more functional communication skills. Gail's aggregate trend line for non-word vocalizations demonstrates a decrease, while Ben's shows an increase, and Ramon's appears relatively stable. However, all three participants' percentages show great variability across sessions of PECS training. Thus, the current research demonstrates no clear relationship between changes in spoken words and non-word vocalizations. One participant, Ben, frequently mumbled, thus it is hypothesized that his increase in non-word vocalizations may eventually contribute to a greater increase in intelligible spoken words, as his word approximations become more clear. The other two participants, Gail and Ramon, more frequently displayed such non-word vocalizations as shrieks, humming, and self-stimu-

latory vocalizations. While echolalia has been demonstrated to have communicative functions, other non-word vocalizations do not have the same support, thus may not be as likely to be replaced by intelligible word utterances (Prizant & Duchan, 1981; Prizant & Rydell, 1984).

Future Research

Future research involving AAC, including the PECS, with young children with ASD may take several directions. First, few studies have systematically examined the relationship between PECS and speech production. Thus, to determine external validity of the current research, direct replication is recommended (Kazdin, 1982). The appearance of similar results would verify generality of the findings of the current research to other individuals with similar characteristics. Systematic replication (i.e., replication involving variation of elements of the intervention) is also necessary to parse out the unique characteristics of PECS (e.g., visual nature of pictures, delayed modeling strategy, inclusion of participants' preferred items) that caused the increase in word utterances in the current research participants.

Future research may also involve measures of fidelity of implementation. While Pyramid Educational Consultants, Inc. provides PECS workshops and manuals to train parents and practitioners, questions remain involving whether the system is consistently implemented following the manual's protocol. Research involving fidelity of treatment may involve the following questions: (a) what percentage of implementer criteria is followed correctly; (b) how much of the protocol can be disregarded with the same rate of mastery in participants; and (c) what amount of training is necessary to ensure a high rate of implementation fidelity.

In summary, the current study investigated the effects of an AAC system, PECS, on the word utterances of three young children with ASD and related characteristics. As described throughout this manuscript, the intervention appeared to have positive effects and applicability for such children, ages three to seven years, in the current educational system. Word utterances in all three participants increased throughout PECS training. It is hoped that the current research will bring to the attention of educational practitioners the possibility of such AAC systems positively impacting the word utterances of individuals with ASD.

ACKNOWLEDGMENTS

This work was supported in part by Pi Lambda Theta (PLT), International Honor Society in Education, which awarded a research grant to the first author, and Dr. Andrew Bondy and Ms. Lori Frost, who provided many of the materials to support this research. This investigation was completed, in part, as a requirement toward the first author's doctoral degree at the University of Kansas.

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