

*USING THE PICTURE EXCHANGE COMMUNICATION
SYSTEM (PECS) WITH CHILDREN WITH AUTISM:
ASSESSMENT OF PECS ACQUISITION, SPEECH,
SOCIAL-COMMUNICATIVE BEHAVIOR, AND PROBLEM BEHAVIOR*

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The picture exchange communication system (PECS) is an augmentative communication system frequently used with children with autism (Bondy & Frost, 1994; Siegel, 2000; Yamall, 2000). Despite its common clinical use, no well-controlled empirical investigations have been conducted to test the effectiveness of PECS. Using a multiple baseline design, the present study examined the acquisition of PECS with 3 children with autism. In addition, the study examined the effects of PECS training on the emergence of speech in play and academic settings. Ancillary measures of social-communicative behaviors and problem behaviors were recorded. Results indicated that all 3 children met the learning criterion for PECS and showed concomitant increases in verbal speech. Ancillary gains were associated with increases in social-communicative behaviors and decreases in problem behaviors. The results are discussed in terms of the provision of empirical support for PECS as well as the concomitant positive side effects of its use.

DESCRIPTORS: autism, communication, PECS

One hallmark feature of children with autism is deviant or delayed speech and language skills (Charlop & Haymes, 1994). Behavioral interventions such as discrete-trial procedures (Lovaas, 1987), incidental teaching (Hart & Risley, 1980), delay procedures (Charlop, Schreibman, & Thibodeau, 1985; Halle, Marshall, & Spradlin, 1979), and pivotal response training (Koegel, Koegel, & Schreibman, 1991) have been used to increase speech, but more than 50% of chil-

dren with autism still remain mute (Charlop & Haymes, 1994). Other interventions have been developed to focus on alternative communication strategies for children who do not develop speech. These programs involve nonvocal methods of communication (Mustonen, Locke, Reichle, Solbrack, & Lindgren, 1991) and include sign language, picture-point systems, electronic devices, and other picture-communication systems (Carr & Kologinsky, 1983; Mirenda & Schuler, 1988; Reichle & Sigafos, 1991).

The picture exchange communication system (PECS) is a pictorial system that was developed for children with social-communication deficits (Frost & Bondy, 1994). The system uses basic behavioral principles and techniques such as shaping, differential re-

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inforcement, and transfer of stimulus control via delay to teach children functional communication using pictures (black-and-white or color drawings) as the communicative referent. The pictures are kept by the child on a notebook (PECS board) with Velcro®. The child is taught to use his or her PECS board and create a "sentence" by selecting picture cards (e.g., "I want" card plus "juice" card) and delivering the cards to a communicative partner as a request for a desired item. PECS emphasizes teaching a child to initiate requests (for seen and unseen items), respond to questions (e.g., "What do you want?"), and make social comments (e.g., "I see [object]").

The PECS system has gained widespread use nationally and internationally with children with autism and is appealing for several reasons (Siegel, 2000; Yamall, 2000). First, the system requires few complex motor movements on the part of the speaker and does not require the listener to be familiar with an additional language such as sign language (Bondy & Frost, 1994). Second, the PECS system has a relatively low cost and is portable and suitable for use in many settings. Third, case reports indicate that the system can be taught relatively rapidly. Bondy and Frost (1993) described the procedures used to train school-based staff in Peru to use the system over a 5-day period. Although no formal data were collected, the school reported that over a 3-month period, approximately 74 children began the PECS training procedures and many children had progressed to the second training phase. Finally, the PECS system incorporates functional communicative responses that promote meaningful interactions between the child and the environment (Frost & Bondy, 1994). The PECS system is unique among alternative communication systems in that it requires the child to approach a listener and initiate interaction prior to emitting a ref-

erential communicative act (Bondy, 2001; Frost & Bondy, 1998).

Several informational reports have suggested that a large number of children who learn PECS also develop spoken language. Bondy and Frost (1994) indicated positive outcomes for 85 children who were taught to use PECS. Schwartz, Garfinkle, and Bauer (1998) reported that children who initially had a limited spontaneous vocal repertoire continued to have increased spontaneous language following PECS training, whereas children with no initial spontaneous vocalizations did not make gains (Bondy & Frost, 1994). Other positive effects have been suggested with the use of PECS. Anecdotal reports have indicated that the use of PECS may result in a decrease in problem behavior and improved social behavior (Bondy & Frost, 1994; Peterson, Bondy, Vincent, & Finnegan, 1995). However, it is important to note that none of these reports included an experimental research design to eliminate potential confounding factors such as maturation effects.

Perhaps because of these potential advantages and the pragmatic features, PECS has been adopted in the autism treatment community. However, the widespread use of PECS has preceded the empirically controlled investigations needed to support it (Charlop-Christy, 2000; Yamall, 2000). Since the publication of the PECS training manual in 1994, no controlled studies demonstrating the efficacy of the PECS procedure have been published. Instead, support for PECS has come in the form of anecdotal reports (Bondy & Frost, 1993), program evaluation data (Bondy & Frost, 1993, 1995; Schwartz *et al.*, 1998), and A-B design case studies (Peterson *et al.*, 1995).

Thus, the purpose of the present study was to empirically assess the utility of PECS with children with autism using a single-subject design. First, the efficacy of the PECS program was assessed in terms of the

amount of training needed for mastery of PECS skills by children with autism. Second, the collateral effects of PECS training on several behaviors were assessed to provide empirical evaluation of ancillary gains that have been anecdotally reported following PECS training. The primary dependent measures were spoken language in the form of spontaneous and imitative speech (Charlop et al., 1985; Charlop & Trasowech, 1991; Charlop & Walsh, 1986; Hart & Risley, 1968; Ingenmay & Van Houten, 1991; Matson, Sevin, Box, & Francis, 1993; Matson, Sevin, Fridley, & Love, 1990). Collateral effects on social-communicative behavior and problem behavior were also assessed.

METHOD

Participants

Three boys with autism participated in this study during biweekly sessions at an afterschool behavioral treatment program. Each participant had been diagnosed with autism by two independent agencies. All children had an extensive history of verbal speech training that had been ineffective in teaching the children to communicate. These children were chosen for the study because they were the first 3 children in the program after the initiation of the study that did not speak or rarely spoke and needed language programming. Alex was a 12-year-old Ethiopian-American boy with an expressive language age-equivalent score of 1 year 2 months on the Minnesota Child Developmental Inventory (deAyora & White, 1987). His receptive vocabulary age-equivalent was 1 year 9 months on the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1981). He had very little spontaneous speech. The term *spontaneous speech* was used in the present study to refer to speech that occurred without a vocal prompt or vocal stimulus, regardless of the presence of visual prompts (Charlop & Haymes, 1994;

Charlop & Trasowech, 1991; Hart & Risley, 1968; Ingenmay & Van Houten, 1991; Matson et al., 1990, 1993). Alex also imitated three-word phrases upon request but relied on gestures (e.g., pointing, leading people, shaking head, etc.) as a primary means of communication. He typically did not make eye contact, initiate interactions with others, or engage in unprompted play. He did not exhibit problem behavior during the observations conducted in this study.

Jake was a 3-year 8-month old Chinese-American boy. The Vineland Adaptive Behavior Scales reflected an overall functioning ability in the 10-month to 18-month range (11 months for socialization domain, 10 months for communication domain) (Sparrow, Ball, & Cicchetti, 1984). He displayed no spontaneous speech, but made consistent attempts to imitate sounds and primarily used gestures (e.g., pointing, pulling a person towards an object) to indicate his desires. He exhibited very limited appropriate play skills and typically used toys as self-stimulatory objects. Jake exhibited several topographies of problem behavior including tantrums, grabbing objects from other people, leaving his seat during work, and disruptive behaviors (e.g., throwing or kicking objects). Problem behavior typically occurred when desired items were unavailable and when nonpreferred tasks were presented.

Kyle was a 5-year 9-month old Korean-American boy. He had a receptive vocabulary of less than 1 year 9 months on the PPVT and no spontaneous speech. He typically attempted communication by leading adults by the hand, pointing at preferred objects, and pushing away nonpreferred objects. No other clear gestural communication attempts were evident. He attempted to imitate sounds and only occasionally made unprompted requests for food items. He had poor eye contact and rarely displayed appropriate independent play. He also displayed several topographies of problem behavior in-

cluding tantrums, grabbing objects from others, leaving his seat during work, and disruptive behavior (throwing and banging objects). Problem behavior typically occurred when he was unable to obtain a desired item or when nonpreferred tasks were presented.

Settings

PECS training. PECS training trials were conducted in several settings as the program progressed. Initial training trials were conducted in a room (2.1 m by 2.1 m) with a one-way observation mirror. The room contained a table and two chairs positioned facing each other. Individually identified preferred items were displayed in clear plastic containers or on a table, but they remained out of the child's reach until training trials were conducted. All sessions were videotaped through the one-way mirror. Later training sessions were conducted in empty classrooms at the university immediately adjacent to the clinic, at the child's classroom at school, and at the child's home. These additional locations were selected because they were more similar to the settings in which the child would eventually use PECS (e.g., home, school) than the initial training setting. They were incorporated to promote generalization of PECS use in everyday life; however, generalized PECS use in these settings was not evaluated in the current investigation. The additional settings allowed increased distance between the child, the therapist, and the location of the PECS materials, as suggested in the PECS training manual.

Free-play sessions. Free-play sessions occurred approximately once per week for each week prior to, during, and following completion of PECS training. All free-play sessions were conducted in a room (2.4 m by 4.5 m) with a one-way observation mirror. The room contained a variety of age-appropriate toys such as toy cars and trucks, building blocks, stuffed animals, basketball and hoop, electronic toys, a small table and four

chairs, and pretend kitchen equipment. The child moved freely around the room with any available item. The room contained a mounted stationary video system that was used for taping all sessions.

Academic sessions. All academic sessions occurred approximately once per week for each week prior to, during, and following completion of PECS training. Sessions were conducted in a room (2.1 m by 2.1 m) with a one-way observation mirror. The room contained a table, two chairs positioned facing each other, and toys and academic tasks displayed in clear plastic containers that remained out of the child's reach until work was initiated. Although the physical surroundings for this setting were similar to the PECS training setting, there were several notable differences. No PECS training materials were used during these academic tasks in order to assess any ancillary gains associated with PECS. Instead, other training materials were present (e.g., flash cards, colored blocks), and the tasks presented were traditional preacademic and academic tasks (e.g., prepositions, color identification, receptive labeling, handwriting). All sessions were videotaped through the one-way mirror.

PECS Materials

A three-ring binder (15 cm by 23 cm) was used as a communication board to teach PECS. The binder contained several strips of Velcro® (sentence strips), an "I want" card, an "I see" card, "yes" and "no" cards, and black-and-white pictures (2.5 cm by 2.5 cm) of preferred items. These cards were either taken from *The Picture Communication Symbols Combination Book* (Mayer-Johnson Company, 1994) or constructed from pictures of desired food items as recommended by Frost and Bondy (1994). The sentence strip was a piece of strengthened paper with Velcro® on the bottom and top. The strip was attached to the PECS book on the lower right corner, and picture cards could be at-

tached to the top layer of the strip to create sentences. For initial training trials, the picture cards were 5 cm by 5 cm. Later, the picture cards were reduced to 2.5 cm by 2.5 cm. Although the participants were not selected because of two-dimensional discrimination skills, each child demonstrated these skills in ongoing curricular assessments.

Design

A multiple baseline design across participants was used to evaluate the collateral effects of PECS training on multiple dependent measures in the domains of speech, social-communicative behavior, and problem behavior in free-play and academic settings. One session was conducted for each of the two settings each week in random order. Initiation of the PECS training phase was based on the stability and trend in vocalizations in both the play and the academic settings. Follow-up sessions were conducted at 10 months after the last regular session on 3 consecutive weeks for 1 child (Alex).

Procedure

All procedures during the play and academic sessions remained constant across all phases. During each play or academic session, the therapist provided five spontaneous speech opportunities and five verbal imitation opportunities. These opportunities occurred at the beginning of each minute, alternating between a spontaneous speech trial and an imitative speech trial similar to the procedures used by Charlop et al. (1985). For spontaneous speech opportunities, the therapist held up a desired object and waited 10 s for the child to make a vocalization. No vocal prompts or models were used. An appropriate vocalization resulted in access to the object, and no vocalizations resulted in continuation of other play or continuation of academic demands with no access to the object. For the verbal imitation opportunities, the therapist held up a desired object

and modeled a word or phrase related to the object (e.g., "spin," "bounce the ball"). Imitation resulted in access to the object, and no vocalization resulted in no response by the therapist. Therapists used typical clinic procedures for dealing with problem behavior (i.e., planned ignoring, a contingent "no," and differential reinforcement of other behavior), and these procedures remained constant through all phases.

In the free-play setting, 10-min interactions between the child and a therapist were videotaped once per week. The therapist was instructed to play and speak with the child throughout each session (e.g., playing ball, drawing, building with wooden blocks, or verbally encouraging appropriate toy play). The child was able to move freely around the room, sit or lie on the floor, and play with any available toy. The therapist also interacted with items and remained immediately responsive to any child initiations.

Ten-minute academic sessions were also conducted once per week. During these sessions, the child was asked to perform tasks included in his regular curriculum at the afterschool program. The child was required to remain seated directly across from the therapist, who presented tasks tailored to each child's skill level (e.g., following simple commands, receptive labeling, handwriting, and prepositions).

Stimulus preference assessment. In preparation for PECS training, a preference assessment was conducted to identify the most preferred items for use during PECS, training as indicated in the PECS procedures manual (Bondy & Frost, 1994). The first step of this assessment was carried out by observing the child in a play area and by asking parents and therapists what the child preferred. Next, the therapist sat in a chair facing the participant with a flat board on his or her lap and conducted a multiple-stimulus-without-replacement assessment (DeLeon & Iwata, 1996; DeLeon, Iwata, &

Roscoe, 1997). The therapist presented an array of items identified in the first step on the board and allowed the child to select one and briefly interact with the item. The items were typically food items and toys. These items were not usually available in the play setting or the academic setting.

This procedure was repeated until three to five highly preferred items were identified. An item was considered preferred when the child reliably reached for it within 5 s, and an item was highly preferred if it was selected more than three times. Once an item was identified as highly preferred, it was removed from the array and replaced with another item. Repeated brief assessments were conducted each day to determine which preferred items would be included in the child's PECS training trials. During these assessments, a three- to five-item array of the preferred items was presented and the child was instructed to pick one. This brief procedure was repeated again in a training session if the child's interest in the initially selected item appeared to wane.

PECS training. The children were taught PECS during 15-min training sessions twice per week. Weekly play and academic probes continued during PECS training, but all training trials were conducted in separate sessions in which the primary dependent measures were trials and training time required to reach criterion. PECS was taught using the prompting and differential reinforcement procedures described by Frost and Bondy (1994). This protocol involves six training phases: (a) physical exchange, (b) expanding spontaneity, (c) picture discrimination, (d) sentence structure, (e) "What do you want?" and (f) commenting. The first steps involve mand training (e.g., Skinner, 1957) and include strategies that promote generalization of skills to new settings (e.g., Stokes & Baer, 1977). The child learns to deliver a picture to an adult, who subsequently provides the object and states the

name of the object. Later phases incorporate strategies such as a delay (Charlop *et al.*, 1985) between picture delivery by the child and vocal models and reinforcement by the adult to promote vocal communication. The final phase incorporates a form of impure tact training in which the child is taught to describe an object in his or her environment. A description of the six phases of PECS is presented in Table 1. For a more detailed description of the PECS training procedure, see Frost and Bondy (1994). The criterion for successful completion of each phase was 80% unprompted successful trials in a 10-trial block.

Posttraining. Several sessions were conducted in the weeks immediately following completion of the PECS training protocol. The PECS book was available during all other nonresearch clinic activities at our clinic and at the child's home from this point forward.

Long-term follow-up. One participant was available for long-term follow-up. Approximately 10 months after the study, the play and academic setting observations were repeated once per week for 3 consecutive weeks.

Dependent Measures and Data Collection

Two dependent measures were collected in the PECS training setting. A frequency count was made of the number of trials to criterion for each phase (80% of trials with correct unprompted responding). In addition, the total number of minutes until criterion was met was recorded for each phase.

Several dependent measures were collected during the play and academic sessions by coding videotapes using a cassette recorder and tape marking 10-s intervals. Communication in the form of responses during the spontaneous and imitative speech opportunities served as the primary dependent measure, but data were also collected on other social-communication and problem behav-

Table 1
Description of Each Phase of PECS Training According to Guidelines Set by Frost and Bondy (1994)

| Phase | Title | Content |
|-------|------------------------|--|
| 1 | Physical exchange | The child is taught to hand a blank picture card to a communicative partner. |
| 2 | Expanding spontaneity | The child is taught to go to his PECS board, get a picture card, seek out a communicative partner, and place the card in his or her hand to receive a reinforcer (mand training). The distance between the child, the board, and the listener (adult) is gradually increased and the response is trained in new settings. |
| 3 | Picture discrimination | The child is taught to discriminate among multiple pictures on the PECS board. |
| 4 | Sentence structure | The child seeks out their PECS board, creates a "sentence" on the sentence strip by combining the "I want card" and the card of a desired item, seeks out a communicative partner, and gives him or her the sentence strip. The listener reads the strip back to the child, inserting a fixed delay between the words "I want" and the item label. Additional social praise is added if the child independently provides the label during the delay. |
| 5 | "What do you want?" | The child is taught to respond to the question, "What do you want?" |
| 6 | Commenting | The child is taught to respond to the question, "What do you see?" by selecting a card depicting the same object and combining it with an "I see" card to obtain an unrelated reinforcer (impure tact training or matching to sample). |

Note. The criterion was 80% correct (based on 10 trial blocks) for each of the six PECS phases.

iors. See Table 2 for complete operational definitions and examples for each behavior.

In the play and academic demand settings, each speech trial was scored as correct or incorrect, and data are presented as percentage of trials with correct responding. Spontaneous speech was scored only during spontaneous speech trials (e.g., the therapist held up a desired object and waited 10 s for a vocalization). A trial was scored as correct if the child responded with a related verbalization (e.g., saying "ball" or "throw" upon seeing a ball). Verbal imitation was scored only during the verbal imitation opportunities (e.g., the therapist held up a desired object and simultaneously modeled a word or phrase related to the object (e.g., "spin," "bounce the ball"). A trial was scored as correct if the child responded with a related ver-

balization (e.g., "bah" or "ball" as imitation for "ball"). Responses were coded as incorrect if the child responded with an unrelated verbalization (e.g., "shoe" as imitation for "ball" or when seeing the ball), no vocalization, or an unintelligible vocalization. The percentage of trials with correct responding was computed for each type of speech by dividing the number of trials scored correct by the total number of speech trials (five) and multiplying by 100%.

The mean length of utterance (MLU) was scored for each instance of spontaneous speech that occurred at a spontaneous speech opportunity. Although other spontaneous speech may have occurred throughout the session, these vocalizations are not included in the data presented. Mean length of utterance was defined as the total number

Table 2
 Dependent Measures and Operational Definitions for Collateral Behaviors Observed in the Academic and Play Settings

| Category | Behavior | Setting | Measure | Operational definition |
|----------------------|------------------|-----------|-------------------------|--|
| Social-communicative | Cooperative play | Free play | Percentage of intervals | Child engaged in the same activity (e.g., basketball, puzzles, board games) with the therapist for at least 10 s. |
| | Joint attention | Free play | Percentage of intervals | (a) Observing same object for 5 s. (b) Referential look between therapist and an object. (c) Established common attention focus with therapist. |
| | Requesting | Free play | Frequency | Labeling object while pointing or reaching for it, handing the therapist PECS cards, verbal requests. |
| | Initiation | Free play | Frequency | Independent approach to therapist with vocal or nonvocal attempt to engage in conversation or play (e.g., pulling on therapist's shirt to get attention, "play," handing therapist a toy). |
| | Eye contact | Free play | Percentage of intervals | Child looked into therapist's eyes for 2 s. |
| Problem | Tantrums | Both | Percentage of intervals | Crying, yelling, or whining. |
| | Grabbing | Academic | Frequency | Attempting to take object from therapist's hands before it is offered or to take object from container. |
| | Out of seat | Academic | Percentage of intervals | Leaving the chair during ongoing task presentation. |
| | Disruptions | Both | Frequency | Throwing or banging objects, destroying objects, kicking or hitting an object, wall, floor, or person, knocking objects off a table. |

of spontaneous intelligible phonemes (Leonard, Miller, & Brown, 1980) made during the spontaneous speech trials for a session divided by the total number of trials in which a child made a spontaneous request.

Several other social-communicative behaviors were scored in the free-play sessions only: cooperative play, joint attention, requesting, initiation, and eye contact. Some of these behaviors are communication as well as social behavior (e.g., initiation, requesting) but are not captured by our spontaneous and imitative speech data because they did not occur in spoken form. Problem behaviors were scored for the 2 participants

who exhibited problem behavior. The four problem behaviors scored for Jake and Kyle were tantrums, grabbing, out of seat, and disruptions. Grabbing and being out of seat were scored in the academic setting only. Disruptions and tantrums were scored in both settings.

Interobserver Agreement

One of several trained observers scored a subset of the sessions independently. During observer training, observers were provided with operational definitions of the target behaviors to be scored and examples of each behavior. The criterion for completion of

training was 80% agreement with a criterion tape scored by a primary observer. The operational definitions remained available throughout subsequent coding. Interobserver agreement was calculated by dividing the total number of agreements between the raters by the total number of agreements plus disagreements, and then multiplying by 100%.

A second observer scored the PECS training sessions, and the average interobserver agreement for Alex was 92% for total session time and 96% for number of trials. The average interobserver agreement for Jake was 99% for total session time and 92% for number of trials. The average interobserver agreement for Kyle was 99% for total session time and 97% for number of trials.

Observers scored each speech response by noting the type of trial (spontaneous or imitation) and whether the trial was correct or incorrect. Observers also coded each response by counting the number of utterances emitted. A second observer independently scored 39% of sessions for speech, and the average interobserver agreement across all speech behaviors was 98% for Alex, 95% for Jake, and 94% for Kyle.

Other behaviors were scored as either percentage of 10-s intervals with occurrence of the target behavior or frequency. The dependent measure for each ancillary behavior is included in Table 2. A second observer independently scored 43%, 39%, and 35% of sessions for social-communicative behaviors, and the combined interobserver agreement was 84%, 90%, and 84% for Alex, Jake, and Kyle, respectively. A second observer scored 25% of sessions for problem behaviors, and the average interobserver agreement across all problem behaviors was 93% and 95% for Jake and Kyle, respectively. A breakdown of interobserver agreement for each specific target behavior is available from the authors.

RESULTS

Acquisition of PECS

All 3 children met criterion (80% correct for each phase) for each PECS phase and acquired PECS skills during an average of 170 min (range, 165 to 176) and an average of 246 total trials (range, 224 to 276). Different phases were associated with different numbers of trials to criterion, but progress was generally more rapid during Phases 3 and 5 (range, 4 to 8 min; range, 8 to 16 trials), and Phases 2 and 4 generally took more time and trials (range, 31 to 89 min; range, 45 to 108 trials).

Speech

Spontaneous speech and imitation. The data for the academic sessions are shown in Figure 1. Alex's spontaneous speech increased from an average of 28% of trials during pretraining to 100% of trials during posttraining. Imitation occurred during 76% of trials during pretraining and 90% of trials during posttraining. Alex also met criterion during 1-year follow-up probes, displaying spontaneous speech on an average of 93% of the trials and imitation on 100% of the trials. Jake did not display any imitation or spontaneous speech during pretraining during academic sessions but he displayed spontaneous speech on 83% of trials and imitation on 80% of trials during posttraining. Kyle rarely displayed spontaneous speech ($M = 2\%$) or imitation ($M = 4\%$) during pretraining academic sessions. After PECS training, he displayed spontaneous speech on an average of 68% of the trials and imitation on 72% of the trials.

Data for the free-play sessions for Alex, Jake, and Kyle are shown in Figure 2. Alex displayed some spontaneous speech ($M = 44\%$) and imitation ($M = 68\%$) in pretraining, and demonstrated gains in each area (spontaneous speech, $M = 90\%$ of trials; imitation, $M = 80\%$ of trials) during post-

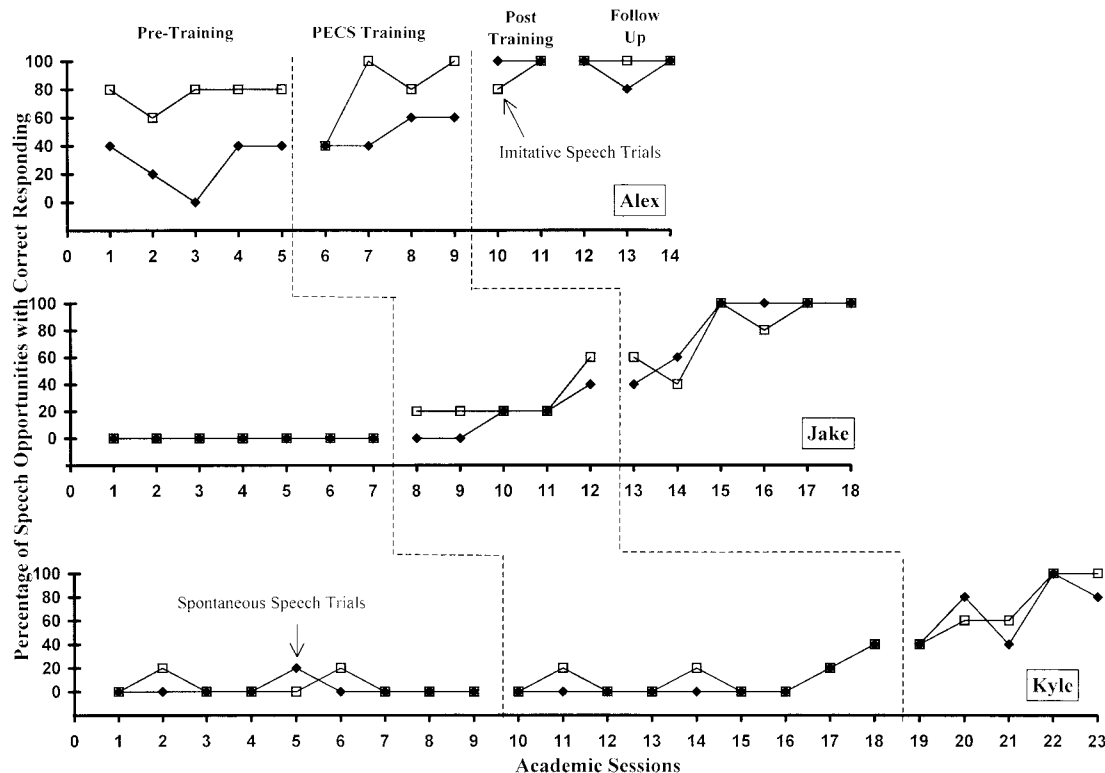


Figure 1. Percentage of structured opportunities with spontaneous speech and imitation during academic sessions for Alex (top panel), Jake (middle panel), and Kyle (bottom panel).

training. During 1-year follow-up sessions, spontaneous speech and imitation gains were maintained (100% of trials). Jake did not display any imitation or spontaneous speech during pretraining and demonstrated gains in both spontaneous speech ($M = 63\%$ of trials) and imitation ($M = 73\%$ of trials) during posttraining sessions. Kyle did not display any speech during pretraining but demonstrated gains in both spontaneous speech ($M = 80\%$ of trials) and imitation ($M = 72\%$ of trials) during posttraining sessions.

Mean length of utterance (MLU). The MLU data from both academic and play sessions are depicted in Figure 3. During pretraining, Alex displayed an MLU of 2 words in academic sessions, and an MLU of 1.7 words in free-play sessions when making spontaneous requests. Following PECS training, Alex displayed an MLU of 2 words

in academic sessions and an MLU of 2.3 words in play sessions when making spontaneous requests. At 1-year follow-up, he displayed an MLU of 2.7 words in academic sessions and 2.6 words during free-play sessions. Jake did not display any speech during pretraining academic sessions or play sessions. During posttraining sessions, the MLU was 2 words in the academic setting and 1.8 words in the play setting. Kyle also displayed an increase in MLU when making spontaneous requests. During all pretraining academic sessions, he made only one spontaneous request (a single word) in comparison to an MLU of 1.5 words during posttraining when making spontaneous requests. He displayed an MLU of 2.4 words during the last two academic sessions when he reached criterion. Similarly, he did not use spontaneous speech during free-play sessions during pretraining. He displayed an MLU

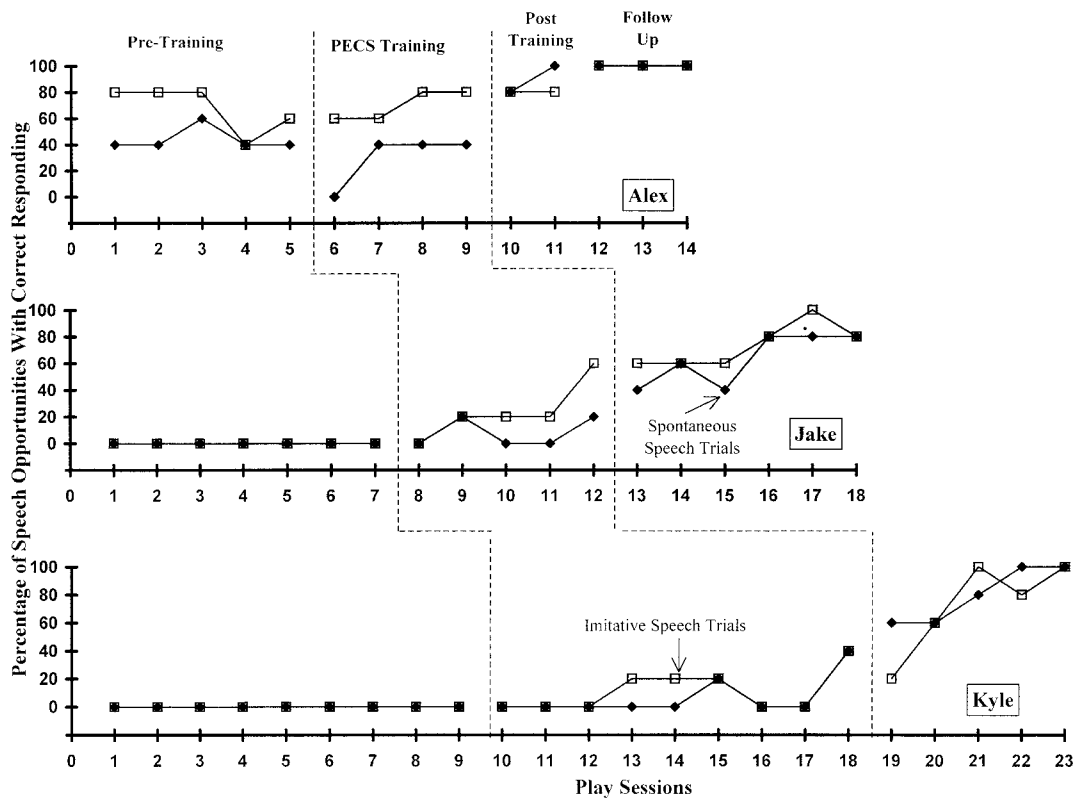


Figure 2. Percentage of structured opportunities with spontaneous speech and imitation during play sessions for Alex (top panel), Jake (middle panel), and Kyle (bottom panel).

of 1.6 for all posttreatment free-play sessions and an MLU of 2.5 during his last two free-play sessions when he reached criterion.

Social-Communicative Behaviors

The data for social-communicative behaviors in the free-play sessions for Alex, Jake, and Kyle are shown in Figure 4. For Alex, either joint attention, eye contact, or toy play occurred during an average of 25% of intervals during baseline and increased to an average of 54% of intervals following PECS training and an average of 61% of intervals at long-term follow-up. An average of 11 requests and initiations per session occurred during baseline, which increased to 28 per session following PECS training and 52 during follow-up sessions. For Jake, either joint attention, eye contact, or toy play occurred during an average of 16% of intervals during

baseline and increased to an average of 41% of intervals following PECS training. An average of 2.9 requests and initiations per session occurred during baseline, which increased to 38 per session following PECS training. For Kyle, either joint attention, eye contact, or toy play occurred during an average of 20% of intervals during baseline and increased to an average of 39% of intervals following PECS training. An average of 2.8 requests and initiations per session occurred during baseline, which increased to 27 per session following PECS training.

Problem Behavior

The problem behavior data from both academic and play sessions are depicted in Figure 5. For Jake, tantrums and out of seat occurred in the work setting during an average of 14% of intervals in baseline and

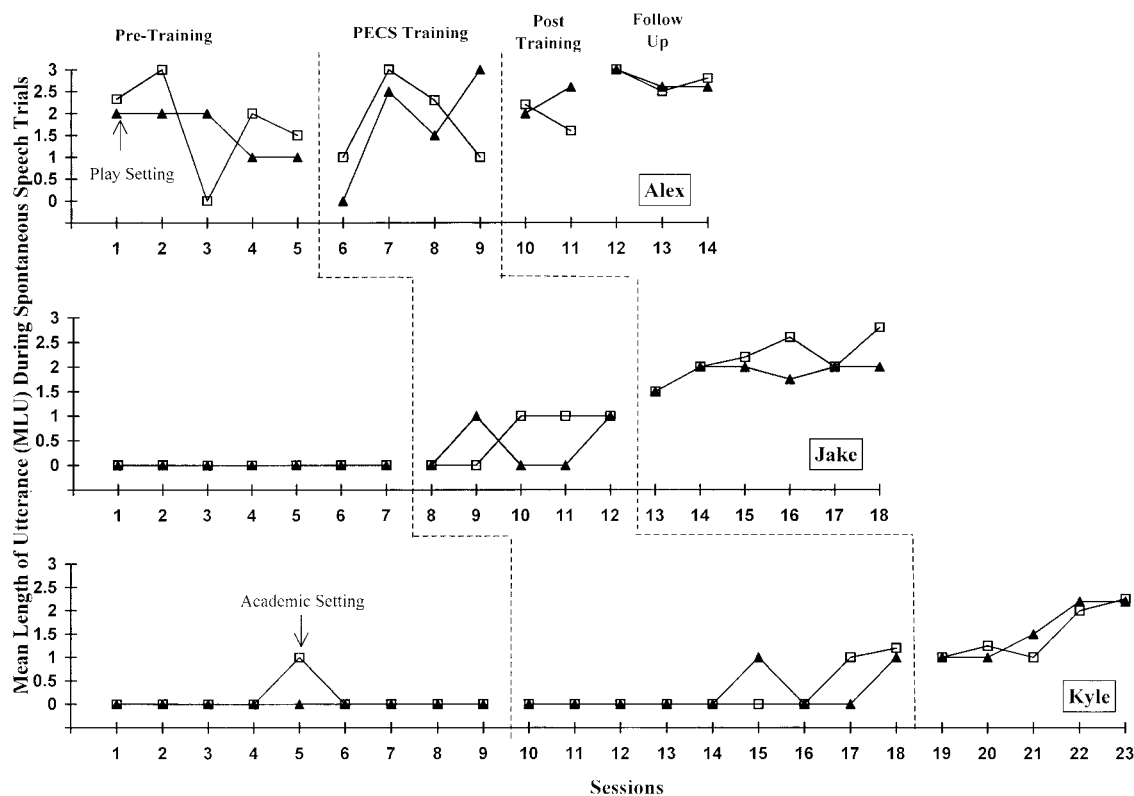


Figure 3. Mean length of utterance (MLU) for spontaneous speech opportunities during academic (open squares) and play (filled triangles) sessions for Alex (top panel), Jake (middle panel), and Kyle (bottom panel).

decreased to an average of 5% of intervals following PECS training. An average of 24 disruptions and grabs per session occurred in baseline, which decreased to an average of 9.5 per session following PECS. For Kyle, tantrums and out of seat occurred in the work setting during an average of 7% of intervals in baseline and decreased to an average of 0.5% of intervals following PECS training. An average of 12.3 disruptions and grabs per session occurred in baseline, which decreased to an average of 2.6 per session following PECS. For Jake, tantrums occurred in the play setting during an average of 15% of intervals in baseline and decreased to an average of 2% of intervals following PECS training. An average of 1.7 disruptions per session occurred in baseline, whereas none occurred following PECS. For Kyle, tantrums occurred in the play setting during

an average of 13% of intervals in baseline, and none occurred following PECS training. An average of 2.7 disruptions per session occurred in baseline, which decreased to an average of 0.2 per session following PECS. Overall, percentage reduction scores were computed for each behavior in each setting ($N = 12$). A 70% or greater reduction was observed for 10 of 12 behaviors, and four behaviors were eliminated. The greatest change for Jake was the elimination of disruptions in the academic setting. The greatest change for Kyle was the elimination of tantrums in the play setting.

DISCUSSION

In the present study, 3 children with autism were taught to use the picture exchange communication system (PECS). A multiple

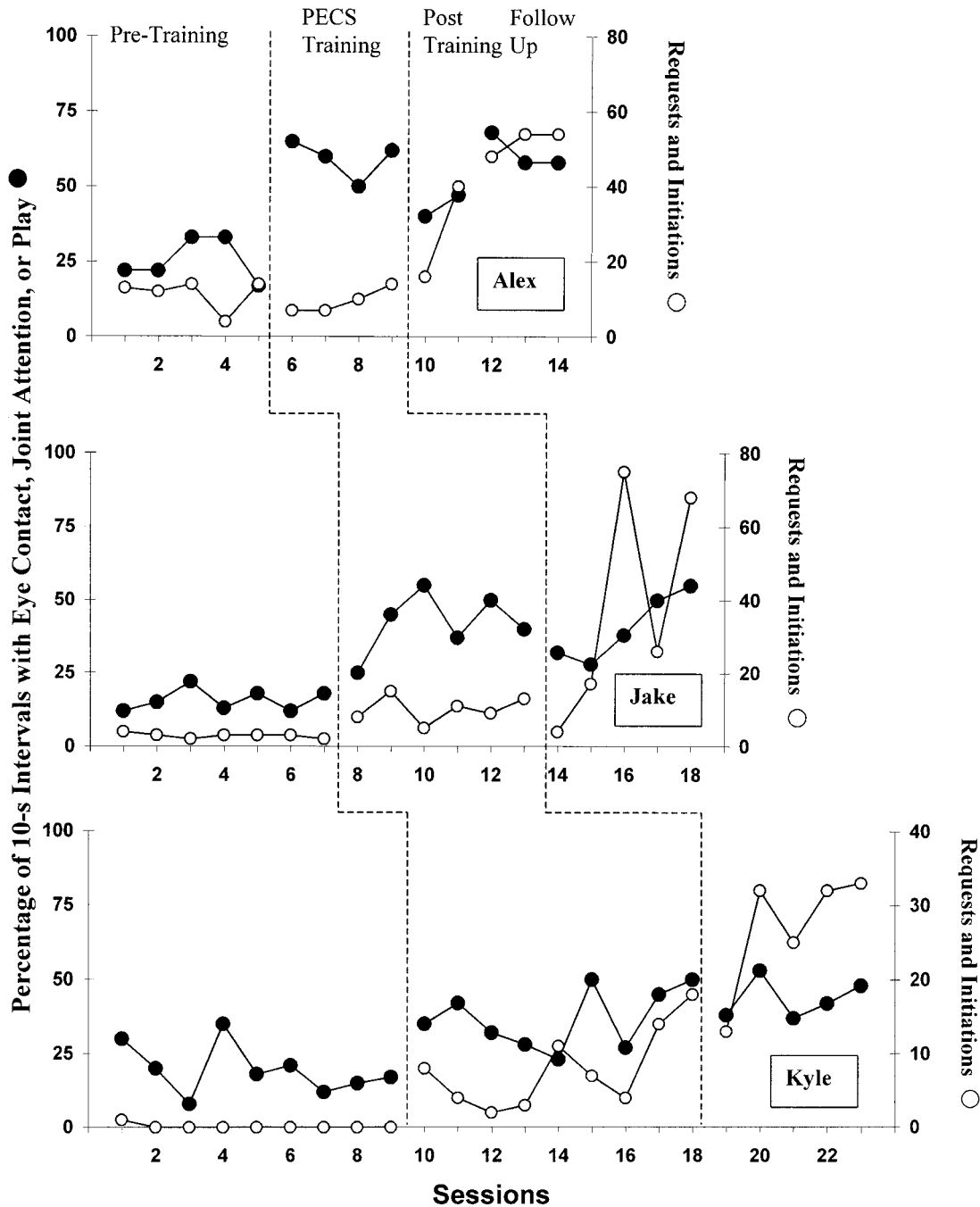


Figure 4. Percentage of 10-s intervals with cooperative play, joint attention, or eye contact (filled circles) and combined frequency of initiations and requests (open circles) for Alex (top panel), Jake (middle panel), and Kyle (bottom panel).

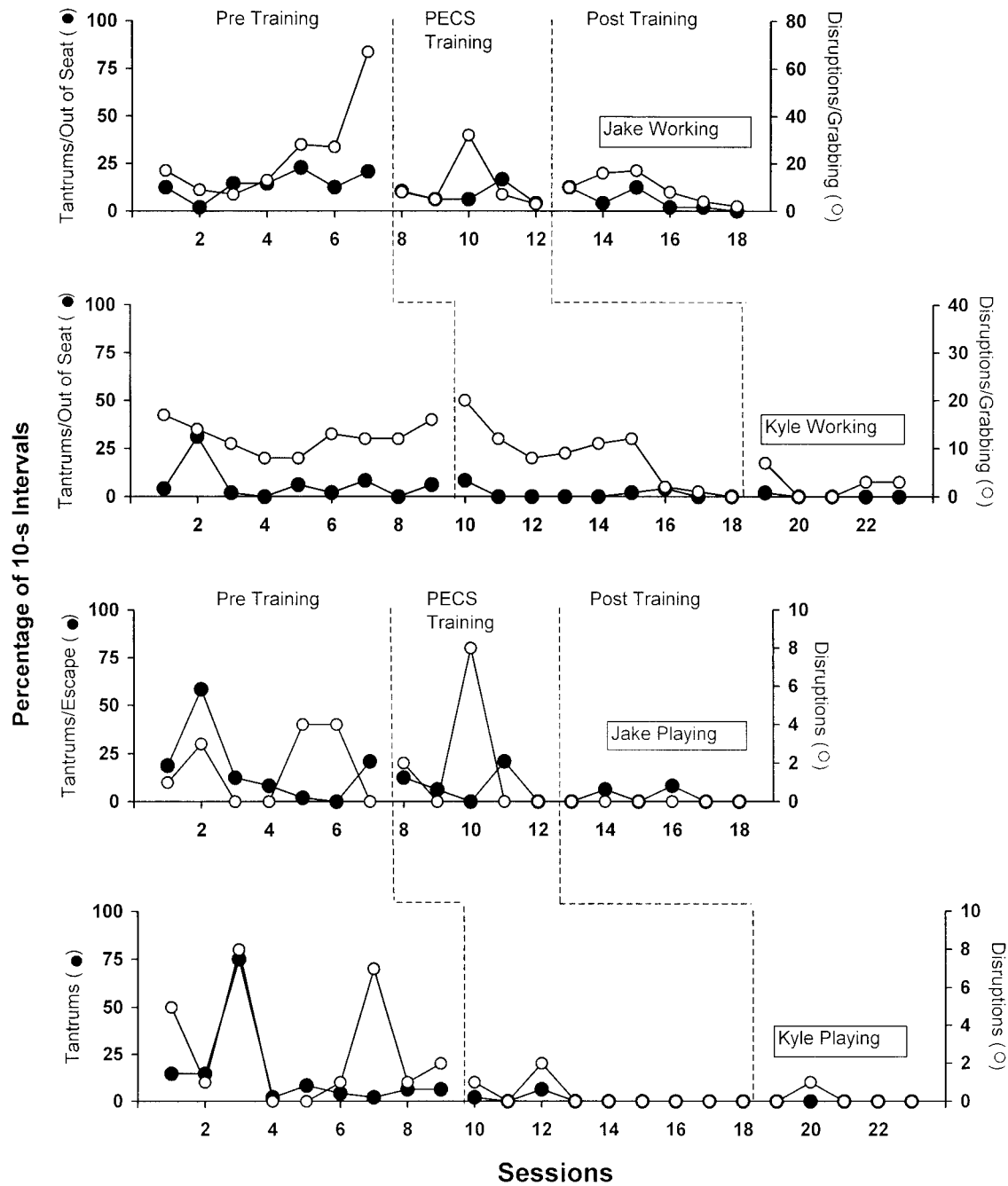


Figure 5. Percentage of 10-s intervals with tantrums and out of seat (filled circles) and frequency of disruptions and grabbing (open circles) in work settings for Jake (top panel) and Kyle (second panel). Percentage of 10-s intervals with tantrums (filled circles) and frequency of disruptions (open circles) in play settings for Jake (third panel) and Kyle (bottom panel).

baseline design across children illustrated the effects of the PECS training procedure on several behaviors related to pictorial communication: vocal communication, social-communicative behaviors, and problem behaviors. This study provides the first empirical evidence to support previous informational reports (i.e., Frost & Bondy, 1994) and program evaluations (Schwartz et al., 1998) and adds experimental data to support the already-widespread use of PECS.

All 3 children mastered PECS use within a relatively short time (see trials to criterion and minutes of training in the results). These children were the first 3 children identified who had extensive language skill deficits, and no children were eliminated or selected based on the presence of any preliminary skills. Thus, there is minimal likelihood that quick skill acquisition was due to selection procedures.

Several factors included in the PECS training procedure may explain the relatively quick skill acquisition for these children. First, children with autism frequently learn tasks presented in a structured concrete format more easily than tasks presented in a more abstract format (Schopler, Mesibov, & Hearsey, 1995). The structured context and concrete nature of the physical exchange is perhaps better suited for learning for children with autism than traditional spoken language of an item's label. The use of picture cards in PECS provides a visual representation for communication and incorporates visual discriminations as part of the communication exchange, which may enhance the speed of learning for children with autism (Happé & Frith, 1995). Specifically, a PECS card (two-dimensional visual stimulus) is exchanged for an item (three-dimensional visual stimulus). This visual-visual discrimination may have resulted in more easily understood communication for the child than did mixed auditory-visual discriminations, which have typically been

more difficult (Harapiak, Martin, & Yu, 1999). Third, the PECS protocol focuses on creating establishing operations and functional relations with the environment. In the PECS protocol, children are taught to use mands to specify their desired reinforcers (e.g., "I want juice"), allowing the children to obtain important objects and events in their environment. The child's own fluctuating deprivation states are establishing operations that make communication more likely to occur. This direct establishment of contact with a listener prior to emitting a referential communicative act is an important feature of PECS that may enhance the success of manding for children with autism. Finally, PECS incorporates the prompting procedure of delay (e.g., Charlop et al., 1985; Charlop & Walsh, 1986; Touchette, 1971) that occasions transfer of stimulus control of the communicative behavior to the presence of the desired item.

Emergence of Speech

Although the demonstration of the efficacy of PECS is important in and of itself, the increase in speech is perhaps the most important finding. Several features of the PECS system may contribute to the emergence of vocal as well as pictorial communication. First, the PECS program teaches functional communicative behaviors that incorporate strong reinforcers and are likely to be supported in natural environments. Many communication training programs initially teach labeling, which involves teaching the child to identify an object with a symbol, a hand gesture, or a vocal response (Carr, 1982; Lovaas, 1987). The focus on mands in the PECS program may indeed contribute to the initiation of verbal behavior (Skinner, 1957).

The development of speech may also arise from the pairing of the phrase spoken by the adult (e.g., "I want juice") with the pictorial communicative act of handing a PECS sen-

tence strip to a communicative partner. Thus, vocal and pictorial mands are presented simultaneously and, if the child begins to imitate the vocalizations in later phases of PECS, the two responses may be reinforced simultaneously.

The use of delay, inherent in the PECS protocol, may have also contributed to promoting speech (Charlop *et al.*, 1985; Charlop & Trasowech, 1991). Indeed, the data during PECS training may support this notion. All of the children displayed more speech gains as delay was incorporated into the training procedure during Phases 4 and 5. Thus, the transfer of stimulus control from the teacher's verbalization of "Good, you're telling me, 'I want juice'" to the presentation of the PECS card (juice card on the PECS board) and then to the mere presence of the object (juice) occurred (e.g., Charlop *et al.*, 1985; Touchette, 1971).

It is important to note that the emergent speech produced by the children in this study occurred with novel persons, in two nontraining settings, and with stimuli not directly included in the training settings. The PECS procedure may promote generalization by incorporating child-selected reinforcers, multiple settings, and interactions with multiple trainers that occur throughout the day in their natural environment. These techniques have been described by Stokes and Baer (1977) as ways to promote generalization. Also, the use of child-initiated requests and child-selected reinforcers through the child's daily routine is similar to many naturalistic teaching strategies that focus specifically on promoting speech across environments and listeners (cf. Hart & Risley, 1968).

The children in this study displayed some ability to imitate, which may have facilitated their verbal behavior. The children in this study may be similar to the children in Schwartz *et al.* (1998) whom she called "talkers." These children demonstrated some

ability to imitate or produce spontaneous speech during and after PECS training in comparison to the "nontalkers," who were able to use PECS as a functional communication but did not show the dramatic increase in speech production.

Collateral Improvements

Another finding is that children's social-communicative behaviors increased after learning to use PECS. Eight social-communicative behaviors were observed with initiations and requests increasing the most, concomitant with PECS training. Joint attention also increased in all 3 children, although not as much as initiations and requests. Mundy, Sigman, and Kasari (1990) and Mundy, Sigman, Ungerer, and Sherman (1986) suggested that there is a direct positive relation between joint attention and communication in children with autism. Improvement in one, as in this study, may have stimulated an increase in the other. As a whole, however, the results from the present study are consistent with prior research on the relations between communication and social behaviors (e.g., Baker & Cantwell, 1987; Black & Logan, 1995; Mundy *et al.*, 1986, 1990; Prizant *et al.*, 1990; Shabani *et al.*, 2002; Thiemann & Goldstein, 2001).

These results also indicate that increased communication skills occurred in conjunction with decreases in problem behaviors. The results of this study are consistent with prior research on the inverse relation between communication skills and problem behaviors (Carr & Durand, 1985; Durand & Carr, 1991; Hagopian, Fisher, Sullivan, Acquistio, & LeBlanc, 1998). Each participant experienced a decrease in one or more problem behaviors. It is important to note that these findings are concomitant changes rather than causal, and a functional analysis of the problem behaviors was not conducted.

Limitations of the study include the small

sample size, and replication with additional subjects is needed. Specifically, future research should explore a profile analysis of which children would likely become the “talkers” (Schwartz et al., 1998), as in the present study, and which ones would not. Future studies might assess the generalization of treatment effects across home, school, and clinic settings. Finally, this study primarily examined collateral effects of PECS training rather than direct use and generalization of PECS use across settings. Anecdotally, we can report that all children used their PECS books in addition to vocal communication during posttraining, but this was not the focus of the present study.

The present study demonstrated the efficacy of the PECS protocol with 3 children with autism, the emergence of speech, and the collateral gains in social-communicative behaviors and concomitant decreases in problem behavior. These findings together support the use of PECS by providing the first empirically controlled data on the PECS program. We encourage the evaluation of PECS and the continued pursuit of visually presented speech training programs for children with autism.

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STUDY QUESTIONS

1. What is PECS, and what types of behavioral strategies are used during PECS training?
2. What direct and indirect effects of PECS were evaluated in this study?
3. Briefly describe the procedures used to determine whether spontaneous speech and verbal imitation were acquired.
4. Although the specific reinforcers delivered for correct responses during PECS training were not described, based on the information contained in Table 1, what was the relationship between responses and reinforcers in Phase 2 and in Phase 6?
5. Describe the effect of PECS training on spontaneous speech.
6. Describe the effect of PECS training on social-communicative and problem behavior.
7. What features of PECS were suggested by the authors as potential contributors to the emergence of speech, and which of these, in your opinion, seems the most tenable?
8. What procedures were implemented in an attempt to promote stimulus generalization?

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