Original Article

Teaching Verbal Behavior Using the Picture Exchange Communication System (PECS) With Children With Autistic Spectrum Disorders

Kumiko YOKOYAMA*, Nozomi NAOI*, and Jun-ichi YAMAMOTO**

The Picture Exchange Communication System (PECS) is widely used with non-verbal children with autistic disorders as an Augmentative and Alternative Communication (AAC). Most of the participants in prior research on that method, although referred to as non-verbal, had initial vocal repertoires of at least a few words. The purpose of the present study was to examine whether 3 elementary-school-age children with autistic disorders whose vocal repertoires were severely limited, such as only a few phonemes, could acquire elementary communication skills using PECS. The present study incorporated task analysis, in which a sequence of picture-exchanging behaviors was divided into 4 components. The results demonstrated that all 3 children acquired the basic component of PECS within a short period. Data from the task analysis revealed that, with increased use of PECS, their prior mode of communication (grabbing, reaching, or crying) was gradually replaced, thereby indicating the reinforcing value embedded in PECS. In addition, the present data suggest that PECS training produced collateral behavioral changes, such as an emergence of intelligible vocalization, even in students who had previously had severely limited vocal repertoires.

Key Words: Picture Exchange Communication System (PECS), task analysis, severely limited vocal repertoires, vocalization, children with autism

Introduction

In pursuit of an empirically validated intervention program, many studies have been conducted that examine the effectiveness of early intensive interventions for children with autism (e.g., Lovaas, 1987; Smith, Groen, & Wynn, 2000). Nevertheless, even after participating in such programs, one-third to two-thirds of children with autism remain nonverbal (Magiati & Howlin, 2003). How much training is required to determine if a child would eventually develop speech still remains unclear. If they fail to develop speech, many children will have spent a considerable amount of time

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participating in a speech-oriented intervention, and yet still not have an appropriate means of communication (Frost & Bondy, 2002; Bondy & Frost, 2002). Therefore, it is important to implement a more appropriate and effective alternative communication method before these children inadvertently develop inappropriate ways to communicate.

The Picture Exchange Communication System (PECS) was developed by Frost and Bondy (1994) as a tool of communication for non-verbal children. In this system, a child approaches another person in order to exchange a picture card for a desired item. On receipt of the picture card, the other person provides the item depicted on the card. Communication training through the use of PECS has been demonstrated to be an effective intervention strategy, especially for children with autistic disorders (e.g., Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Koita & Sonoyama, 2004; Kravits, Kamps, Kemmerer, & Potucek, 2002; Magiati & Howlin, 2003; Schwartz, Garfinkle, & Bauer, 1998).

The following characteristics of PECS training have been identified as critical factors that promote effective communication (Bondy, Tincani, & Frost, 2004; Koita, Sonoyama, & Takeuchi, 2003). First, PECS capitalizes on simple motor behaviors that are easy to learn or already in a child’s behavior repertoires, such as reaching for or picking up something. Due to this simplicity, extensive training is not needed for the prerequisite skills, thereby making it possible to ensure communication from the very beginning of the training. In addition, since pictures are a commonly used medium of communication in the natural community, most members of the community would easily understand what was being communicated, without the need for explicit training.

In order to implement PECS training for autistic children with severely limited expressive and/or receptive language skills, it is necessary to analyze the basic process of how such children acquire the PECS skills. Koita and Sonoyama (2004) trained an autistic child with severely limited vocal repertoires to use PECS at home. The child successfully learned to request desired items, and to answer simple questions, such as “What do you want?” through the use of PECS.

The present study was designed to extend the findings of previous research by examining the basic process of picture exchange for three children with severely limited vocal repertoires. Two of the children, Students A and C, had no intelligible vocalization and no repertoires of receptive labeling skills. That is, they could not perform a task in which they were required to select a picture card corresponding to a word spoken by an adult. The other child, Student B, had no intelligible vocalization, but he could select more than 30 pictures when matching words were spoken.

The process of PECS training was divided into the following four components; (1) reaching, (2) discriminating, (3) picking up, and (4) exchanging. Reaching was defined as a stretching out the hand toward a picture card placed on a desk, and not toward an object held by the trainer. Discriminating was defined as selecting the picture card corresponding to a desired item from among two or four other picture cards. Picking up was defined as lifting the card with the hand. Exchanging was
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defined as giving a card that had been picked up to a communication partner, and receiving a desired item from that person.

Since PECS is an artificial communicative means, we must examine whether the acquired skills could be utilized and maintained in a student's daily environment. The present study assessed the generalized use of PECS in a setting outside of the training, and with a novel communicative partner, the child's parent. The effectiveness of PECS training was assessed after conducting training at the child's home, where the experimenter was the trainer. Finally, maintenance of PECS use 6 or 8 months after termination of training was assessed.

It is important to examine what function the verbal behavior has that has been acquired by exchanging pictures to receive the desired items. In order to establish picture-exchanging skills, "mand" training (Skinner, 1957) should first be given (Bondy & Frost, 2002). "Mands" are defined as a form of response that is reinforced by a characteristic consequence.

Yamamoto and Mochizuki (1988) indicate that whether an acquired requesting response such as "Give me" is controlled by a specific consequence should be evaluated. Their research assessed the function of an acquired requesting response by adding a procedure in which an adult offered an item other than the one requested. Applying this framework to the present study would enable us to assess whether the mand acquired through the use of PECS was controlled by a characteristic consequence. In this procedure, the acquired response can be considered to have the function of manding if the child rejects any offered item other than the one requested.

An additional critical characteristic of PECS is its applicability as a tool for promoting intelligible vocalizations (Hourcade, Pilotte, West, & Parette, 2004). Previous studies on PECS (e.g., Charlop-Christy et al., 2002) reported that, following the acquisition of PECS, a number of positive behavioral changes was observed, such as the emergence of spontaneous speech, enhancement of other social communicative behavior, and a reduction in problem behavior.

Although Schwartz et al. (1998) indicated that a child's initial vocal repertoire must be at least several words before speech emerges, we selected for the present study children with autism who had no expressive and/or receptive language skill, because we wanted to examine whether PECS is an effective system for children with severely limited language skills.

In the regular PECS training procedure, the trainer provides the verbal label of the desired item when receiving the picture card from the child (Frost & Bondy, 2002). In addition to the presentation of such a verbal model, the trainer in the present study simultaneously tapped on the picture card with the "mora rhythm" of the label of the desired item. For example, when one of the children brought a picture of ramune (an edible item) to the trainer, the trainer verbally modeled the label "ra-mu-ne" while simultaneously tapping on the picture three times, corresponding to the timing of the utterance of each mora (i.e., "tap-tap-tap"). The tapping step was incorporated because it was thought that it would encourage vocalization. The verbal label and tapping were provided regardless of whether the child imitated the verbal
model and/or tapping.

In sum, the present study had several purposes. First, we wanted to examine whether three children with autism who had no expressive and/or receptive language skills prior to the study could acquire basic communication skills using PECS in the laboratory and/or with home-based teaching. Second, we wanted to clarify the conditions of function, generalization, and maintenance of PECS. Third, we examined whether intelligible vocalizations would emerge concomitant with the acquisition of PECS through imitation and the mora-rhythm-tapping.

Method

Participants

Three Japanese children with a diagnosis of autism (DSM-IV; American Psychiatric Association, 1994) participated in the present study. Student A and Student B attended preschool. Student C attended a special school. The children had no functional vocalization. All three of them fell in the severe autistic range (52.5 to 54) according to the criteria of the Childhood Autism Rating Scale (CARS; Schopler, Reichler, De Vellis, & Daly, 1989).

Student A was a 5-year-old boy. His scores on the Kyoto Scale of Psychological Development (KSPD; Ikuzawa, Matsushita, & Nakase, 2001) indicated that his age-equivalent level of functioning was 8 months on the language and sociability subscale and 11 months on the cognitive and adaptive subscale. He could request food either by gestures or by vocalizing an “a” sound, which was the only sound in his vocal repertoire. He rarely responded to vocal commands, requests, or calls from other people.

Student B was 5 years 11 months old. His scores on the Kyoto Scale of Psychological Development were 11 months on the language and sociability subscale, and 18 months on the cognitive and adaptive subscale. He typically requested food or toys by pulling an adult’s hand toward the item, or by uttering “ya” or “itu”, which are an approximation of “yatte” (please do it) in Japanese. However, he could not vocalize these sounds as a single word. He could receptively identify more than 30 common objects.

Student C was 7 years 11 months old. His score on the Kyoto Scale of Psychological Development indicated that his level of functioning on the language and sociability and cognitive and adaptive subscales was 11 months and 20 months, respectively. Student C made no attempt to approach or interact with others unless he wanted something. On such occasions, he expressed his requests either by clapping his hands twice, or by pulling an adult’s hand toward the object. He could not receptively identify any objects.

Prior to the present study, only Student C had had preliminary training on PECS. He had received a couple of sessions in which he had acquired the ability to request one item, “soap bubbles” (sha-bo-n-da-ma in Japanese). In this training, the trainer first blew soap bubbles for a short period, and then waited for a response from

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the boy. At the same time, a picture card illustrating soap bubbles was placed on the desk near where the student was sitting. If the boy reached for the bottle of soapy liquid, a prompter sitting behind the child gently guided the child’s hand toward the picture of soap bubbles and prompted him to pick it up and put it to the trainer’s open hand. These prompts were gradually faded until eventually the boy could independently pick up the card and exchange it for the bottle of soapy liquid. However, we did not examine whether he could use PECS to request items other than the soapy liquid or to make requests in other situations.

Settings
Training sessions were conducted at a room at the university for Student A; for the other children, weekly home-based sessions were conducted. The room for each child’s training contained a small table or desk on which the picture cards could be placed. Training was conducted by two trainers, a communicative partner who sat facing to the boy and played the role of a listener, and a prompter who sat behind the boy and provided physical, gestural, or vocal guidance if the child failed to complete the required task correctly. The typical sequence of a PECS training trial is illustrated in Fig. 1.

PECS Materials
The picture cards were different in material or size for each boy. Images of potentially reinforcing items were glued to a 5.5 cm × 5.5 cm cardboard. Above each picture, its label was printed in hiragana in 12 point type. Examples of each child’s desired items are listed in Table 1.

Design
A multiple-baseline design across participants and a changing-criterion design within participants were used. Furthermore, task analysis of the sequence of behavior constituting PECS was conducted. The behavioral sequences were divided into four components (for details, see the baseline section). The results were analyzed in this framework, in order to evaluate qualitative differences in acquiring each component.

Procedure
Stimulus preference assessment. On the basis of interviews with the children’s parents and naturalistic observations during free play, a variety of potentially reinforcing items was identified in an initial assessment. In order to determine the most preferred item on a given trial, a stimulus preference assessment was conducted on every trial as follows: first, the communicative partner presented a 4-item-array of potentially reinforcing items, selected from among the ones identified in the initial assessment. The 4 items were presented out of the child’s reach, held by the partner either on a tray or in two bags, depending on the item. If the child reached for an item within 5 seconds, the item was classified as a reinforcer for that trial. If the child did not reach for or attend to any of the items within 5 seconds, one of the items in
TABLE 1 Exdoimales of Desired Items for Each Student

<table>
<thead>
<tr>
<th>Student</th>
<th>Desired Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>baby-star (edible), chocolate, ramune (edible)</td>
</tr>
<tr>
<td>B</td>
<td>dakko (activity), Slinky (toy), balloon</td>
</tr>
<tr>
<td>C</td>
<td>kebue (toy), soap bubbles, beads, strings</td>
</tr>
</tbody>
</table>

Stimulus Preference Assessment to Identify Reinforcer:
Presentation of a 4-item array

Trial Begins:
Presentation of a 4-item array and the corresponding pictures

Completion of Component I:
Spontaneously reaching for a picture card within 5 seconds

Completion of Component II:
Discriminating

Completion of Component III:
Picking up a card

Completion of the Component IV:
Handing over the picture

Reinforcement:
Delivery of the item requested

FIG. 1 Typical Sequence of a PECS Training Trial
Completion of components I to IV was required to receive the object requested. Dashed arrows indicate the flow of the trial when the child made an incorrect response.
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the 4-item-array was replaced with a different item. Stimulus preference assessment was then repeated with this new set of items, and it continued to be repeated until the child reached for an item within 5 seconds. That behavior was considered to be an identification of the most reinforcing item. A trial followed this stimulus preference assessment procedure immediately (see Fig. 1). On every trial, this same sequence (stimulus preference assessment, followed by a trial) was repeated. An item used in the previous trial could be included in the next assessment, so long as the child preferred it. Throughout the experiment, except for Probe II and the follow-up assessment at home, an experimenter played a role of a communicative partner.

Baseline. Baseline assessment was conducted to examine whether any of the boys could request desired items using PECS, without utilizing any other mode of requesting, such as hand-leading or screaming.

The first step in baseline was stimulus preference assessment. When the most reinforcing items were identified as described above, the 4-item-array was withdrawn for a few seconds. Then, the prompter placed 4 picture cards on the desk. The 4 picture cards corresponded to the 4 items in the array. That is, there were no distracter items in the 4-item-array. So that the position of the real object would not cue the position of the corresponding picture card on the desk or held in both hands, picture cards were placed in a randomly selected position. Next, the communicative partner presented the 4-item-array (the real objects) again. The trainer then waited 5 seconds to determine whether requesting through the use of the picture would occur.

Based on a task analysis, the target behaviors were defined as follows: (1) Reaching: Stretching out the hand toward any picture card placed on the desk without a prompt within 5 seconds. Selection of a card corresponding to the item identified in the preceding assessment was not required at this point. (2) Discriminating: selecting the picture of the item identified from among two or four other picture cards. The two or four pictures presented corresponded to the items in the 4 or 2-item-array in the preceding stimulus preference assessment. (3) Picking up: lifting the card with the hand. (4) Exchanging: giving a card that had been picked up to a communication partner.

Each trial consisted of stimulus preference assessment followed by components (1) to (4). The results were analyzed in 8 trial-blocks throughout the experiment (baseline, training, probes). Correct responses in baseline were defined as accomplishing the first component within 5 seconds after the re-presentation of the 4-item-array of reinforcing items, followed by successful completion of the components (2) through (4).

When an exchange occurred, the trainer provided a verbal label of the desired item, together with finger tapping corresponding to the "mora rhythm" of the label. The item was given to the child immediately, regardless of whether or not the child imitated the verbal label or finger tapping. However, when incorrect responses occurred, such as selection of a different card or reaching for a desired item without picking up a card and exchanging it for the item, the desired item was presented for
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5 seconds out of the child’s reach, and then the trial was terminated. During the baseline, whether or not a correct response occurred, the item was given to the child at the termination of each trial.

**Training.** All three children were given 1-hr sessions once a week, of which 20 to 30 minutes was allocated for PECS training. On the whole, the training followed the PECS training manual (Frost & Bondy, 2002). According to the manual, the basic sequence of the training should be divided into six phases: (1) requesting through a use of single picture, (2) going some distance to approach the listener, (3) making a discrimination between several pictures, (4) introducing sentence structure within PECS, (5) answering “What do you want?” questions, and (6) commenting about specific features of the environment. However, unlike the outline in the Manual, the present study focused primarily on the four pivotal behaviors (requesting, discriminating, picking up, and exchanging) so that we could capitalize on the children’s current behavioral repertoires.

The initial curriculum of the training was individually determined for each child, depending on his performance during baseline, thereby incorporating a changing criterion design. For example, if a child demonstrated successful discrimination (component 2) with at least 75% accuracy during baseline, all four components were introduced at once at the start of training.

On the other hand, if a child’s performance had been below 75% correct, training started with only three components (component 1, 3, and 4). In that case, this phase could be described as single card training, due to the absence of a discrimination task. The discrimination task was added to the training only after 75% correct responding was achieved on at least two of the other components, requesting (component 1), picking up (component 3), or exchanging (component 4), for two consecutive blocks of trials. The last phase of training, with all four components in effect, was called four-card training for Student B and Student C, whereas for Student A, the last phase of training was two-card training.

During two-card training for Student A, a stimulus preference assessment was done using only two items (2-item array), although the items were occasionally replaced with newly identified reinforcing items. The criterion for completion of PECS training was 75% of trials with correct responding on all four components, for three consecutive blocks of trials.

**Generalization probes.** Immediately following the completion of PECS training, generalization probes were conducted in three different contexts. During all probes, the sequence of trials was the same as in the training except for the variable being probed. Probe trials with time delays were interspersed among otherwise regular training trials, and the total of 8 probe trials made up 8-trial blocks comparable to a regular training block.

In Probe I (PR I, increased distance), the distance between the communicative partner and the child was increased to 3 meters while the student sat at the desk facing four picture cards. In Probe II (PR II, novel communicative partner), the communicative partner was the child’s mother or father. In Probe III (PR III, time
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delay), the communicative partner waited for 10 seconds after receiving a picture card before exchanging the card for the requested item; during the delay, the partner held the card facing the student.

**Long-term follow-up assessments.** Follow-up assessments (FU) were conducted in a training room for one block of trials (8 trials), and at the children's homes for 6 days, approximately 6, 8, and 8 months after the termination of the study for Students A, B, and C, respectively. In the training room, the trainer played the role of the communicative partner, whereas at the children's homes, their parent (usually their mother) was the communicative partner.

For long-term assessments made in the training room setting, the general procedure was the same as in the baseline. For those done in the children's homes, the experimenter asked the boys' mothers to record their children's PECS use for 6 days on a data sheet. When any request was initiated by gestures or other mode of requesting, the mothers were supposed to record the situation and how their child responded.

**Assessment of mand function.** The assessment of mand function was conducted in the training room after the follow-up assessment, for one block of trials (8 trials), which were interspersed in otherwise regular training trials. This assessment was used to examine whether the acquired PECS use was under the functional control of the provided items. In this assessment, the children were offered an item other than the one requested.

In the assessment of mand function, the trainer presented four pictures without the reinforcing items being in view, to avoid having the prior presentation of the reinforcing items, as real objects, inadvertently prompt the children to identify the difference between the item they were given and the one they had requested. After providing an unrequested item, the card that had just been exchanged was returned to the desk.

Correct responses were defined as rejecting the unrequested item, or continuing to use PECS to request the desired item until the child received the item he had requested. Incorrect responses were defined as playing with or consuming the item that had been received, without giving any sign that the item received had not been the item requested. As in training, the assessment of mand function was conducted for 8 trials (1 block of trials), interspersed among regular trials.

**Dependent Measures and Data Collection**

All trials were recorded by a digital video recorder. The percentage of trials with correct responding, averaged across blocks of 8 trials, was calculated for each component during PECS training. For example, when a student reached for a card without any prompt for 8 consecutive trials, it was recorded as 100% trials with correct responding for reaching (component 1). However, when a child was prompted on 4 out of 8 trials, it was recorded as 50% of trials having correct responding. All the components were recorded in this same manner.

The children's spontaneous imitation of tapping and the frequency of vocaliza-
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tions were also measured as dependent variables. Due to these boys’ severely limited vocal repertoires, vocalizations were categorized as (1) vowel only; (2) a babbling: combination of a consonant and a vowel, such as “ma”; or (3) an approximation of a label of the desired item, for example, vocalization of “da-ma” when hearing the communicative partner’s vocal model of “sha-bo-n-da-ma” (soap bubbles).

Another dependent variable was the percentage of vocalization that occurred during PECS training and free play. The percentage of vocalization in each condition was compared using a momentary time-sampling procedure, which made it possible to estimate the relative increase of vocalization associated with PECS training. First, for each child, three sets of 5-min samples of vocalization during PECS training were collected, from the video records, taken from the first session in the baseline, approximately the mid point of training, and the first probe session. Another three sets of 5-min-samples of vocalization during free play in the same session as that sampled for PECS training were collected. Each 5-min-sample was further divided into 10-sec intervals. For 1 sec at the end of each 10-sec interval, it was determined whether a vocalization occurred. If at least one vocalization was observed during that 1 second, an occurrence of vocalization was scored. In addition, the vocalization was categorized as either (1) jargon, that is, an utterance that could not be transcribed into any of the other categories; (2) a vowel utterance, (3) babbling: that is, a combination of a consonant and a vowel; or (4) a word approximating the label of the desired item. The percentage of 10-sec intervals with vocalization in each 5-min-sample was calculated for training and free play.

Interobserver Agreement

Two observers, the first author and an undergraduate student who was not associated with this research, independently assessed, by watching the videotapes, approximately 39% of all blocks, for percentage of correct responding and frequency of vocalization during training, as well as assessing 67% of the data on the frequency in the 5-minutes samples of 10-sec intervals with vocalization both during training and free play. Interobserver agreement was calculated by the number of agreements divided by the total number of agreements plus disagreements, and multiplying by 100. Agreement on the percentage of correct responding was 93%, 96%, 98%, and on scores on the frequency of vocalization, 89%, 90%, 92% for Students A, B, and C, respectively. The agreement scores for the frequency of 10-s intervals with vocalization were 98%, 93%, and 98% for Students A, B, and C, respectively.

Results

Acquisition of the Target Behaviors

The total duration of training and the average number of blocks per session (indicated in parentheses) for Students A, B, and C was 8 months (1.8 blocks), 6 months (2.4 blocks), and 6 months (2.8 blocks), respectively. The data in Fig. 2 show that all students successfully acquired the four target behaviors with a criterion of
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75% correct responding on all components for three consecutive blocks.

During baseline, Student A and Student B reached toward the object when the trainer presented a two- or four-item array of reinforcing items. After the preliminary training, Student C was able to reach for a picture card of soap bubbles, however, when other items were presented during training, reaching toward the object was initially not observed.

As can be seen in the top left panel of Fig. 2, for Student A, the percentage of correct responding in the discrimination was no more than 50% until the 19th block. For that reason, a procedural modification was in the 20th block; pieces of edibles (e. g., chocolate) were glued to the picture cards and covered with epoxy-resin, so that the edibles could be seen but not eaten. The task for Student A was to discriminate between 2 three-dimensional picture cards. Immediately following this modification, his discrimination performance gradually improved, reaching 100% in the 26th block.

In contrast, for Student B (top right panel) and Student C (bottom panel), the percentage of correct discrimination responding was above 85% throughout the training.

Figure 2 also reveals that all the children demonstrated an unstable pattern of responding in the acquisition of reaching toward a picture (component 1, the top-most panel for each child), while the percentage of correct responding for the other components remained high. Student A showed at least 75% correct responding for three consecutive blocks as early as the 9th block, in the acquisition of component 1. However, the difficulty in acquiring the discrimination component was associated with a deteriorated performance on component 1, after the 17th block. Following the implementation of the procedural modification in the 20th block, the performance on component 1 recovered, and after 24th block, it exceeded 75% for three consecutive blocks.

For Student B, correct responding for component 1 was unstable until the 19th block, after which correct responding was above 75% for 5 consecutive blocks. For Student C, an unstable pattern of responding was observed until the 9th block, after which correct responding was above 75% for 9 consecutive blocks.

During the increased distance generalization probe (Probe I), the percentage of correct responding for the increased distance (component 4 in Fig. 2), averaged across probe blocks, was 69%, 81%, and 100% for Students A, B, and C, respectively. All the children demonstrated at least 75% correct responding on all other components. During the generalization probe with the children’s mother or father (Probe II), the percentages of correct responding on components 1 to 4 were all above 87.5%, for all three boys. During the time delay generalization probe (Probe III), the percentage of correct responding on components 1 to 4 was above 87.5% for Student A, and 100% for Student B and C.

Maintenance of the Target Behavior: Long-Term Follow-Up Assessment

All three students demonstrated almost perfect maintenance in the 6- or 8-month
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![Graph showing percentage of trials with correct responding for each component over blocks of 8 trials for students A, B, and C.](image)

**Fig. 2** Percentage of Trials with Correct Responding for Each Component

- **Percentage of trials with correct responding**
  - Baseline (BL)
  - Training (TR)
  - Probe (PR)
  - Follow-up (FU)
  - Assessment of Mand Function (MF)

- **Description of each component**
  1. Reaching toward the picture
  2. Discriminating
  3. Picking it up
  4. Exchanging it
  5. Approaching from a distance
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follow up (FU) in the training room (see Fig. 2). The percentage of correct responding across the four components for the follow the training room was above 87.5% for Student A, 100% for Student B, and above 75% for Student C.

Furthermore, the 6- or 8-month follow up revealed that picture-exchanging behavior had been maintained at home as well, with the median frequency of independent (i.e., unprompted) PECS use per day of 2.5, 5.5, and 3, for Students A, B, and C, respectively. According to the data recorded by the mothers, frequent PECS use was especially evident on weekends in two out of the three children.

In addition, approximately one or two requests, made without the use of PECS (e.g., gestures or leading an adult’s hand), were recorded for all students. For example, when requesting physical interaction (e.g., being held by one's mother), requesting through the use of gestures occurred. On the other hand, when their mother did not understand a request made with gestures or other mode of communication, the children reliably switched their strategy to the use of PECS.

Assessment of Mand Function

Within the 8-trial-block of assessment of mand function (MF), the percentage of correct responding for components 1 to 4 was above 75% for Student A, 100% for Student B, and above 85% for Student C (see Fig. 2). The percentage of correct responses for the assessment of mand function, defined as rejection of the unmatched item or continuing to request until receiving the desired item, were 88%, 88%, and 100% for Students A, B, and C, respectively. The incorrect response observed was giving up the request and walking away when an unmatched item was given. One occasion when Student B made an incorrect response was when, upon receiving an unmatched item (a balloon instead of a cookie), he gave up requesting a cookie, and started to play with the balloon.

Analysis of Vocalization and Tapping During PECS Training

The percentage of vocalizations per response opportunity and the frequency of tapping are illustrated in Fig. 3. Comparison of the baseline data and the data for the time delay (Probe III) reveals that the percentage of intelligible vocalizations, defined as an utterance of approximating a word, per response opportunity, clearly increased (See the bar graphs in Fig. 3). The observed increase, which was the difference between the percentage of word approximation during the baseline and during Probe III, was 25% for Student A, 62.5% for Student B, and, for Student C, an average increase of 12.5%. For all students, throughout the training sessions, the highest frequency of vocalization was observed during the time-delay probes (Probe III). However, the card tapping procedure, which was hypothesized to encourage vocalization, did not appear to have a systematic effect on vocalization (See the line graph in Fig. 3).

Comparison of Vocalization During PECS Training and Free Play

The percentage of 10-sec intervals with four different types of vocalization in
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![Graph showing percentage of vocalization and frequency of tapping](image)

**Fig. 3** Percentage of Vocalization per Response Opportunity and Frequency of Tapping

PRI = Probe I; PRII = Probe II; PRIII = Probe III; FU = Follow-Up Assessment; MF = Assessment of Mand Function.

For Students B and C, increased intelligibility of vocalization, such as word approximations or babbling, was more evident during PECS training than during free play. The combined percentages of word approximation and babbling for the probe sample were 0%, 20%, and 17% during PECS training, as opposed to 0%,
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**FIG. 4** Percentage of 10-s Intervals with Vocalization During Free Play (FP) and PECS Training (PECS) for 5-minute Samples of Sessions, Each for the Baseline, Mid-training, and Probe

0%, and 0% during free play for Students A, B, and C, respectively. The percentage of jargon utterance for the probe sample was 0%, 3%, 23% during PECS training, and during free play, 17%, 17%, and 50%, for Students A, B, and C, respectively. These data indicate that unidentifiable utterances, such as a jargon, were the major type of utterance during free play, while intelligible utterances, such as word approxi-
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mations, were frequently observed during PECS training.

Discussion

In the present study, three autistic boys with severely limited expressive and receptive language repertoires demonstrated successful acquisition in the use of PECS (components I through IV), and generalization of the PECS use at a distance (Probe I), with a different communicative partner (Probe II), or after a time delay (Probe III). The assessment of mand function, in which the boys received something other than what they had requested, indicated that their verbal behavior, acquired through the use of PECS, was under the functional control of a mand. In addition, follow-up assessment 6 or 8 months after the termination of training demonstrated maintenance of PECS use over time, in both a trained and previously untrained setting. The comparison of vocalizations during PECS training and during free play, using a momentary time sampling procedure, indicated an improvement in the intelligibility of vocalization during PECS training. Furthermore, during PECS training, intelligible vocalizations were most frequently observed when the time delay procedure was implemented.

The present study assessed the basic sequence of picture-exchanging behavior, by doing a task analysis that divided it into four components. At an early stage of PECS training, difficulty in acquiring reaching toward the picture card was observed for Students B and C. They frequently extended their arms toward the objects presented by the communicative partner. In other words, reaching toward the object was the dominant response topography, and that, in turn, made it difficult to pick up a card and give it to the communicative partner. In such circumstances, it is important to replace the dominant response topography with a functionally equivalent communicative behavior. However, once picture-exchanging behavior was acquired, reaching toward the picture card became the dominant response topography. This could be attributable to the similarity of the response topography that facilitated the acquisition of picture use in communication, and the fact that the picture exchange was immediately followed by delivery of the reinforcing object.

The data from the task analysis revealed that, those who are capable of motor responses, at least of picking up and exchanging, could successfully acquire picture-exchanging behavior within a short period. Moreover, initially observed behavior, such as pulling an adult’s hand toward the object, were gradually replaced with PECS use. These results indicate that the task analysis was effective for assessing existing components in the students’ repertoires; it enabled us to identify which components were causing difficulty within a chain of picture exchanging behavior.

When considering the acquisition of PECS, another important issue is the examination of whether or not the receipt of a desired item controls the use of PECS, in other words, whether it is under the control of a mand. In the probe in which the boys received something other than what they had requested, more than 88% of the trials of all three children were under the control of a mand. Although an incorrect
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response, such as giving up or playing with the unrequested given item, was observed once each for Students B and C, this could be attributed to the discrete format of the trials, in which trials occurred continuously, thereby increasing the likelihood of satiation.

However, in the natural environment, as indicated by the follow up data recorded by the mothers at home, when a mother could not understand the alternative mode of requesting (e.g., gestures), the children switched their mode of request into PECS, bringing a picture card instead of pointing. These results indicated that, in the natural environment, the students’ use of PECS was reliably controlled by receipt of the specific item requested.

Meanwhile, they used alternative modes of requesting, depending on the occasion, for example, when an alternative mode of requesting was readily understood, without recourse to a picture.

In the present study, even in conditions under which the communicative partner was at a distance, a different communicative partner was present, or when a request made though the use of PECS was not immediately satisfied, the acquired PECS use was maintained without additional training. These results indicate that PECS was firmly established in the students’ repertoires of communication. Moreover, PECS use was maintained 6 or 8 months after termination of the training. These data suggest that communication through the use of PECS had been reinforced by the contingencies in the children’s daily environment.

Improvement in the quality of vocalization during PECS training was another important finding. All three children demonstrated an increased frequency of intelligible vocalization, such as word approximations, especially when the time delay procedure was implemented (Probe III). This result reveals that the time delay procedure was an effective strategy for occasioning vocalization, even for children with severely limited vocal repertoires.

It is also clear that, without direct vocal imitation training, all three boys learned to imitate the vocal model of the communicative partner. Furthermore, when comparing the percentage of 10-sec intervals with vocalizations during PECS training and free play, increased frequency and intelligible vocalizations were observed only during PECS training. Thus, it is plausible to consider that even for these children with severely limited vocal repertoires, PECS training was effective in encouraging vocalization.

The present study included teaching both in the laboratory and at the boys’ homes, for children whose parents agreed to implement training at home. The students’ parents closely monitored the way we trained their children, and they adapted the same strategy when communicating with their children. When visiting the children’s homes, the experimenter assessed potentially reinforcing items naturally present in the daily environment, and suggested possible ways of communicating through the use of PECS.

Ecological assessments at the children’s homes, assessments of effective ways to train parents, and a productive way to encourage cooperation between the research
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institution and the families of the children need to be examined further.

The children in the present study not only learned to use PECS properly, but their requesting repertoires were broadened, so that they became able to select the best strategies according to the current environmental constraints, such as the other person’s ability to comprehend their message. These results replicate findings reported by Koita and Sonoyama (2004). In their follow-up assessment, spontaneous requesting were not constrained to the use of PECS, but, when the PECS book was not in a close proximity, or when the participant seemed to be desperate about some request, also included hand-clapping and leading an adult’s hand.

When a student fails to acquire a specific task after a long period of training, the first priority must be to consider how to support and expand their communication using their existing repertoires, rather than further extending the period of having no means of functional communication. In the present study, a procedural modification was introduced for Student A, due to his inability to acquire the two-dimensional discrimination. The best part of using an Augmentative and Alternative Communication (AAC) such as PECS is that it can be readily utilized by people with severely limited behavior repertoires.

In conclusion, the present study empirically demonstrated the effectiveness of PECS training for children with autism who had severely limited vocal repertoires, and, by using a task analysis of the components of PECS training, provided a useful methodology for identifying the children’s strengths and weaknesses.

A detailed analysis of the basic process of picture-exchange behavior was first demonstrated in the present study. Hopefully, it will contribute to broadening the current strategies of teaching PECS. Future studies should also address introducing sentence structure, and examine whether prolonged PECS training would result in the emergence of speech.

Acknowledgements

This research was supported by RISTEX, JST (the Japan Science and Technology Agency). We thank all the students and their parents who participated in this research.

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—Received August 19, 2005; Accepted February 4, 2006—