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Assessing the acquisition and generalization of two mand forms with adults with severe developmental disabilities☆

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Abstract

The purpose of this study was to determine whether manual sign or the Picture Exchange Communication System (P.E.C.S.) (Frost & Bondy, 1994) would be more effective in teaching mand skills to adults with mental retardation in the severe and profound range. Four participants were taught to mand for four reinforcing items using both communication modalities, in an alternating treatments design. Three of four participants demonstrated criterion performance across all four mands using P.E.C.S. first. Two of those three participants later demonstrated criterion performance for the mands using manual sign. The fourth participant was removed from the study during training due to illness, but her progress indicated greater acquisition with P.E.C.S. Generalization probes conducted at participants' respective residences showed that three participants demonstrated generalization across settings using P.E.C.S., and two participants demonstrated generalization across settings using manual sign. Participants were also more likely to mand for reinforcing items not present using P.E.C.S. than using manual sign.

Keywords: functional communication; developmental disabilities; manding; P.E.C.S.; manual sign; mental retardation

☆This study served as the first author's master's thesis, completed under the supervision of the second author.

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In establishing functional communication skills for individuals lacking verbal abilities, careful attention must be granted towards the selection of the appropriate alternative communication system. Mand repertoires are under control of conditions of deprivation or aversive stimulation, and are reinforced by characteristic consequences (see Skinner, 1957, pp. 35–36). Teaching functional mand skills to nonverbal adults with developmental disabilities is particularly important, because individuals may have long histories of engaging in challenging behaviors to gain access to preferred items.

The Picture Exchange Communication System (P.E.C.S.) (Bondy & Frost, 1993; Bondy & Frost, 1994; Frost & Bondy, 1994) is one alternative form of communication that is frequently employed to establish mand skills. Originally intended for use with children with autism, P.E.C.S. teaches individuals to mand by handing a picture of a desired item to a caregiver, in exchange for the preferred item itself. Often the pictures are contained in a three-ring binder that the individual keeps on his or her person. The rationale behind P.E.C.S. is that the exchange of a picture for a reinforcing item parallels the communicative exchange that takes in a normal conversation (Bondy & Frost, 1993; Bondy & Frost, 1994; Frost & Bondy, 1994). It is believed that P.E.C.S. improves upon picture pointing systems (e.g., Reichle, York, & Sigafoos, 1991) by ensuring that the caregiver actually sees the individual emit the mand. With picture pointing systems, a mand repertoire may be quickly extinguished if the individual points to a picture of a desired item, but the caregiver does not observe the mand. Much evidence supports the effectiveness of teaching children with autism to mand using P.E.C.S. (e.g., Bondy & Battaglini, 1992; Bondy & Frost, 1993; Liddle, 2001; Schwartz, Garfinkle, & Bauer, 1998). Despite the widespread use of P.E.C.S. with children with autism, Frost and Bondy (1994) also advocate for its implementation with other age groups and populations. However, to date, no studies have been reported in which adults with developmental disabilities have been taught to use P.E.C.S. With the current emphasis on community-based living and employment options, P.E.C.S. may be an appropriate form of functional communication for adults with severe developmental disabilities.

Manual sign is second alternative communication system that is often used to teach mand skills. Manual sign involves the use of hand gestures and motions to symbolize spoken words. Some benefits of sign are the fact that it places fewer cognitive and conceptual demands on the individual than speech, and that signs provide an easy model for the learner because they can be held visually static (see Bryen & Joyce, 1986; Bryen & McGinley, 1991). A number of studies have demonstrated the utility of manual sign training for establishing functional communication in individuals with severe developmental disabilities (e.g., Benaroya, Wesley, Ogilvie, Klein, & Clarke, 1979; Carr, Binkoff, Koliginsky, & Eddy, 1978; Carr & Kologinsky, 1983; Faw, Reid, Scheips, Fitzgerald, & Welty, 1981; Remington & Clarke, 1983; Stafford, Sundberg, & Braam, 1988). In this body of literature, manual sign has been used to teach both mand and tact (a response under the control of a specific stimulus that is maintained by

generalized reinforcement, see Skinner, 1957, p. 83) skills to individuals with developmental disabilities.

The selection of an alternative communication form may not always be an easy choice for caregivers. The choice, as suggested by Kiernan, Reid, and Jones (1982), may be determined in part by the caregiver's familiarity with the communication system. Advantages and disadvantages of each communication form were recently summarized by Sundberg (1993). Manual sign, it was suggested, may require prerequisite skills such as visual orientation and fine motor imitation skills (Sundberg, 1993; see also Frost & Bondy, 1994). In addition, a caregiver must understand manual sign in order to be able to reinforce the mand. Manual sign also requires that a distinct response topography be established for each mand, something that could either facilitate or hinder acquisition (see Sundberg & Sundberg, 1990). P.E.C.S., on the other hand, establishes one response topography, the picture exchange, for every mand (Sundberg & Sundberg, 1990). P.E.C.S. requires that an individual's binder be available to him or her at all times, and the preparation of pictures may be laborious for caregivers. Empirical comparisons of the two communication forms are necessary for substantiating these logical distinctions.

The purposes of the reported study were as follows: (1) to determine whether adults with severe developmental disabilities would acquire mand skills using P.E.C.S., and (2) to compare the efficacy of P.E.C.S. training relative to manual sign training on mand acquisition. Four participants were taught four mands each using both P.E.C.S. and manual sign. The number of training trials to attain mastery criterion and the generalization of mands across settings were compared for the two communication forms. Also compared was the number of mands emitted per training block when the reinforcing items were not in view.

1. Method

1.1. Participants

Brian was a 19-year-old male with an IQ of 22, according to the Stanford Binet Intelligence Scale, Form L-M. He was diagnosed with mental retardation in the severe range and expressive and receptive language disorder. He also demonstrated characteristics of autistic disorder. Brian was able to complete most self-help tasks independently. An evaluation report made from a speech/language annual review suggested that Brian would benefit from manual sign training. Brian could spontaneously label up to six objects, but did so inconsistently.

Chris was a 26-year-old male with an IQ of 27, according to the Stanford Binet Intelligence Scale. Chris was diagnosed with mental retardation in the severe range, cerebral palsy, and seizure disorder. Chris had a left-eye prosthesis. Chris made only unintelligible vocalizations, except for the words 'bus' and the name of

his aunt. He was able to perform some self-care tasks independently, but he required assistance with dressing and tying his shoes. Manual sign training had recently been introduced into Chris's programming, but had not been successful.

Jenny was a 40-year-old female with an IQ of less than 18, according to the Stanford Binet Intelligence Scale, Form L-M. She had been diagnosed with Down syndrome, mental retardation in the profound range, and seizure disorder. Jenny was able to perform many self-care tasks independently. Jenny was able to verbally imitate up to 12 words; she also used 9 hand gestures or sign approximations. Previous manual sign training had been ineffective.

Mandi was a 36-year-old female with an IQ of 24, according to the Stanford Binet Intelligence Scale, Revised. Mandi was diagnosed with mental retardation in the severe range and was nonverbal. She was able to independently perform self-care tasks. Mandi initiated interaction with others by pointing, making facial gestures, and grabbing or touching caregivers. An evaluation by a speech/language pathologist recommended that Mandi be taught to use manual sign.

1.2. Setting and stimulus materials

Training was conducted in a secluded, quiet classroom at the participants' developmental training center. The room included a teacher's desk, two tables, and several chairs. Materials included a 1 in. three-ring binder for each participant, with four Velcro strips applied on each page within the binder, spaced apart at least 2 in. from surrounding strips. Pictures were digitized photographs of desired items, sized 2 in. $\times$ 2 in. Tangible and edible items were used as reinforcers. A stopwatch was used to monitor reinforcer access time and delay-to-prompt intervals.

1.3. Design

An alternating treatment design was used to compare the efficacy of P.E.C.S. training and manual sign training. Each participant was taught the same four mands using P.E.C.S. and manual sign. Training was conducted at least three days per week. Sessions typically lasted 30–40 min but not longer than 40 min. Half of each session was allocated for training each communication form. Participants were allowed at least a 5 min break between manual sign and P.E.C.S. training. Sessions were conducted at the same time each day when deprivation levels were believed to be high (i.e., the hour preceding lunch). In order to prevent carry-over effects, the order in which P.E.C.S. and manual sign training occurred each day was randomized, as determined by a random numbers table. The teaching of one communication form first did not occur more than three consecutive days in a row.

Baseline, training, and generalization probes were conducted in 10-trial blocks, with no more than three blocks conducted for each communication form

during a given session. The presentation of a reinforcing item marked the onset of each trial. During training, a correct mand resulted in 15 s reinforcer access. Reinforcers were not available to the participants outside of the training sessions. Correct mands were not reinforced during baseline or during generalization probes. A 1–2 s inter-trial interval (ITI) separated the end of a trial and the onset of the next. Experimenters included the first author of this study, who always served as the communicative partner, and direct care staff, who collected reliability data and delivered physical prompts during Phases 1 and 2 of manual sign and P.E.C.S. training. No verbal prompts or instructions were provided to the participants throughout the study.

During training, two mands were taught simultaneously with each communication form until the participant demonstrated mastery of Phases 1–3 with the particular communication form. A mastery criterion of 80% correct or higher, or 8/10 correct mands per 10-trial training block, was required before a participant could advance from one training phase to the next. Once a participant mastered a particular mand using P.E.C.S. or manual sign, he or she was given the opportunity to emit that particular mand after every three training trials so that the mastered mand would be maintained in the participant's repertoire. The four mands that were taught for each participant, in the order that they were introduced, are shown in Table 1.

Prior to the study, it was ensured that all participants could match 2-dimensional pictures to 3-dimensional objects, and vice versa. It was also ensured that participants could not expressively label any of the reinforcing items.

1.4. Procedure

1.4.1. Stimulus preference assessment

Prior to training, reinforcers were identified through direct observation of each participant at the developmental training center. In addition, caregivers were interviewed regarding each participants' preferred items and activities. Items identified as potential reinforcers were then used in a multiple-stimulus preference assessment without replacement (DeLeon & Iwata, 1996). This was conducted by presenting six to eight items/activities in a horizontal line on the table in front of the participant. If necessary, participants were verbally prompted to choose an item. After selecting the item, the participant was allowed 30 s to engage in the activity or consume the item, after which time the item was removed from the array. After all items had been chosen, the procedure was repeated. This continued at least five times until there was a clear order of preference.

1.4.2. Baseline

During baseline, each participant's ability to mand for each of the four reinforcers that would be used during training was assessed with both P.E.C.S. and manual sign. During the baseline session for P.E.C.S., participants had access to a three-ring binder containing pictures of reinforcers and distracting items, and

Table 1
Number of training blocks to attain mastery criterion with each communication form, per participant, per training phase

	Phase 1		Phase 2		Phase 3	
	P.E.C.S.	Sign	P.E.C.S.	Sign	P.E.C.S.	Sign
Brian						
M&M	1	7	2	1	2	1
Puzzle	1	5	2	2	2	1
String beads	1	2	1	1	1	1
Carrots	1	2	1	2	1	1
Chris						
Pretzel	1	5[a]	1	–[b]	1	–[b]
Cards	1	5[a]	1	–[b]	1	–[b]
M&M	1	–[b]	1	–[b]	1	–[b]
Puzzle	1	–[b]	1	–[b]	3	–[b]
Jenny						
Top	1	3	1	1	2	3
Nuts and bolts	1	3	1	1	3	2
M&M	1	2	1	1	1	1
Cookie	1	1	1	1	1	1
Mandi						
Pretzel	1	4[c]	1	–[b]	2[c]	–[b]
Cards	1	4[c]	1	–[b]	3[c]	–[b]
M&M	–[b]	–[b]	–[b]	–[b]	–[b]	–[b]
Puzzle	–[b]	–[b]	–[b]	–[b]	–[b]	–[b]

[a] Chris did not accurately and independently respond on 50% of trials by the end of the fifth session, so sign training was discontinued.
[b] No training blocks conducted.
[c] Amount of training blocks Mandi received before being removed from study.

the participants were allowed 5 s to hand the experimenter the picture of the reinforcing item that was present on each trial. During baseline sessions for sign, participants were allowed 5 s to emit the correct sign corresponding to the reinforcing item that was present on each trial.

1.4.3. Generalization probes

Generalization of mand skills was assessed at the participants' residences. Probes occurred prior to training and one day immediately following the mastery of all four mands with one communication form. Using P.E.C.S., participants were assessed for their ability to mand for each of the four reinforcing items with only one picture available in their binder, both before and after training (a skill reflective of mastering Phase 1 of P.E.C.S. training. The phrase ''Phase 1 generalization probe'' will be used to refer to this probe). After P.E.C.S. training, participants were also assessed for their ability to mand for each of the four reinforcing items with an array of pictures available in their binder (a skill reflective of mastering Phase 3 of P.E.C.S. training. The phrase ''Phase 3

generalization probe'' will be used to refer to this probe). Generalization across settings was inferred if the participant demonstrated 80% accuracy.

1.4.4. P.E.C.S. training

Procedures for teaching P.E.C.S. were developed by Frost and Bondy (1994). The authors organized the procedures into six phases. In the reported study, training continued until a participant mastered Phases 1–3 with four mands.

The goal of Phase 1 was to teach participants to pick up a picture of a reinforcing item and place it in the experimenter's hand, in exchange for the reinforcing item. The first experimenter was seated at the table across from the participant and served as the communicative partner by exchanging pictures for reinforcers. A second experimenter sat behind the participant to physically assist in the exchange. On each trial, the participant was allowed 5 s to place the picture in the experimenter's open palm, at which time the experimenter said, ''Oh, you want (name of manded item),'' or ''You said, 'I want (name of manded item)' '', and delivered the reinforcer to the participant (Frost & Bondy, 1994). If a mand did not occur or if it occurred incorrectly (such as moving the picture or tossing it), the second experimenter physically guided the participant to pick up the picture and place it in the hand of the experimenter across the table. Physical assistance and the 'open hand' cue were faded over the course of the phase. If a participant was not responding independently on 50% of the trials by the fifth training block, P.E.C.S. training was terminated.

The goal of Phase 2 was to teach the participant to remove an attached picture from the outside cover of the binder, approach the experimenter, and place the picture in the experimenter's hands. Initially, this phase was identical to Phase 1 except that the picture was attached to the outside cover of the binder. The distance between the participant and experimenter was then increased: On the first trial of each block, the experimenter moved halfway between the participant and the door; on the second trial of each block, the experimenter stood in the open doorway; and on the third trial of each block, the experimenter walked outside of the room and remained in view with the reinforcer. If necessary, the second experimenter physically assisted the participant to take the picture and approach the first experimenter to make the exchange. As the participant became successful as the distance between himself or herself and the experimenter increased, the distance between the participant and the binder was gradually increased by 1–3 in. per trial.

The goal of Phase 3 was to teach the participant to discriminate the picture of a desired item from an array of pictures. During this phase, a situation during which the participant was likely to request a particular item was established (Frost & Bondy, 1994). The three-ring binder was presented to the participant with pictures of one highly preferred, contextually appropriate item and one nonpreferred or 'distracter' item. If the participant manded with the distracter item, he or she was delivered the item specified in that picture. If the participant manded with the distracter item again, the second experimenter physically guided the participant to exchange the picture of the appropriate item.

Throughout P.E.C.S. training, the experimenter physically blocked any signing attempts that a participant made, so as to avoid inadvertently reinforcing signing

outside of manual sign training. Participants did not have access to their binders outside of training sessions until the completion of the study.

1.4.5. Manual sign training

Manual sign was taught in three phases that were similar to the three phases in which P.E.C.S. was taught. Some signs were simplifications of the hand gestures used in American Sign Language.

The goal of Phase 1 was to teach participants to emit the correct sign, within 5 s, for the reinforcing item present. When the participant manded correctly, the experimenter responded the same way that he did during P.E.C.S. training. If the participant did not emit the correct sign, the experimenter modeled the sign and waited for the participant to imitate it within 5 s. Modeled prompts were used because previous studies have shown modeling to be effective in teaching manual sign (see Carr & Kologinsky, 1983; Simic & Bucher, 1980), and pilot research suggested that modeled prompts were effective in teaching simple hand gestures to these participants. If the participant still did not emit the sign, the experimenter physically guided the participant to make the sign for the reinforcer. Modeled and physical prompts were gradually faded over the course of the phase.

The goal of Phase 2 was to teach the participant to approach the experimenter and emit the correct sign for the reinforcing item present. The distance between the experimenter and the participant was increased in the same manner as was described for P.E.C.S. training.

The goal of Phase 3 was to teach the participant to emit the correct sign under contextually relevant conditions.

Staff were instructed to ignore sign emissions that occurred outside of training sessions until the completion of the study.

1.4.6. Mands for items not in view

Participants' abilities to emit mands for items not in view were assessed over the course of training. Four opportunities to emit such mands were interspersed within training trials for each block. On these assessment trials, the experimenter removed all reinforcing items from the participant's view. The four pictures and two distracter pictures were available in participants' binders during assessments for P.E.C.S. During both sign and P.E.C.S. training, all mands for items not in view were reinforced.

1.4.7. Dependent measures and interobserver agreement

The percentage of correct trials per block and the number of mands for items not in view emitted during training sessions, for P.E.C.S. and manual sign, were the dependent measures. Reliability was established by comparing two observers' record of the accuracy of each trial for each participant. Agreement was defined as both observers recording an occurrence of the participant independently and accurately manding for a reinforcer. Disagreement was scored if one observer recorded an occurrence when the other did not. Inter-observer agreement was calculated by taking the lower number of recorded correct responses and dividing

that by the higher number of recorded correct responses and then multiplying by 100%. The resulting mean agreement was 100% across 50% of the baseline sessions, 32% of the training sessions, and 50% of the generalization probes.

2. Results

2.1. Trials to mastery

2.1.1. Brian

As shown in Fig. 1, Brian was not able to mand for any of the items using P.E.C.S. during baseline, either at the developmental training center or at his residence. Table 1 shows that Brian attained mastery criterion during Phase 1 of P.E.C.S. training in one 10-trial block for each of the four mands. In Phase 2, he attained mastery criterion for two mands in two blocks each, and for the other two mands in one block each. In Phase 3, he also attained mastery criterion for two mands in two blocks each, and for the other two mands in one block each. Fig. 1 shows that by the eighth training block, Brian began consistently performing with 100% accuracy using P.E.C.S. Fig. 1 also shows that Brian performed with 100% accuracy on both Phase 1 and Phase 3 generalization probes.

As shown in Fig. 1, Brian was not able to mand for any of the items using manual sign during baseline, either at the developmental training center or at his residence. Table 1 shows that Brian attained mastery criterion during Phase 1 of manual sign training in anywhere from two to seven 10-trial blocks. During Phase 2, Brian attained mastery criterion for two mands in two blocks each, and the other two mands in one block each. In Phase 3, he attained mastery criterion using manual sign for all four mands in one block each. Fig. 1 shows that the percentage of trials correct for manual sign was not nearly as high as it was for P.E.C.S. over the course of training; more training trials were required to demonstrate mastery criterion with manual sign. Fig. 1 also shows that Brian scored 100% on both Phase 1 and Phase 3 generalization probes using sign.

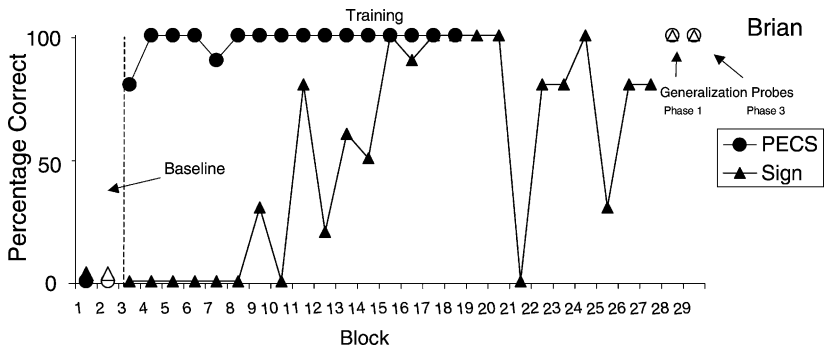

Fig. 1. The percentage of trials correct per block during baseline, training, and generalization probe sessions for Brian. Data are plotted separately for P.E.C.S. and sign.

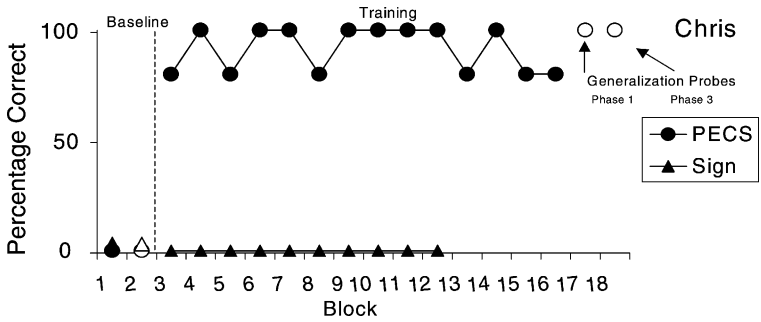

Fig. 2. The percentage of trials correct per block during baseline, training, and generalization probe sessions for Chris. Data are plotted separately for P.E.C.S. and sign.

2.1.2. Chris

As shown in Fig. 2, Chris was not able to mand for any of the items using P.E.C.S. during baseline, either at the developmental training center or at his residence. Table 1 shows that Chris attained mastery criterion during Phases 1 and 2 of P.E.C.S. training in one 10-trial block for each of the four mands. In Phase 3, he attained mastery criterion for three mands in one block each, and the fourth mand in three blocks. Fig. 2 shows that Chris' accuracy scores during P.E.C.S. training were never lower than 80%. The figure also shows that Chris performed with 100% accuracy using P.E.C.S. during both Phase 1 and Phase 3 generalization probes.

As shown in Fig. 2, Chris was not able to mand for any of the items using manual sign during baseline, either at the developmental training center or at his residence. Fig. 2 shows that Chris was responding with 0% accuracy by the fifth block of Phase 1 of manual sign training. For this reason, manual sign training was discontinued for Chris.

2.1.3. Jenny

As shown in Fig. 3, Jenny was not able to mand for any of the items using P.E.C.S. during baseline, either at the developmental training center or at her residence. Table 1 shows that Jenny attained mastery criterion during Phases 1 and 2 of P.E.C.S. training in one 10-trial block for each of the four mands. In Phase 3, she attained criterion performance for each mand in one to three 10-trial blocks. Fig. 3 shows that Jenny's accuracy was at 100% by the 12th block of P.E.C.S. training. Fig. 3 also shows that Jenny performed with 100% accuracy during both the Phase 1 and Phase 3 generalization probes using P.E.C.S.

As shown in Fig. 3, Jenny was not able to mand for any of the items using manual sign during baseline, either at the developmental training center or at her residence. Table 1 shows that Jenny attained mastery criterion for all mands during Phases 1 and 2 of manual sign training in one to three 10-trial training blocks. In Phase 3, she attained mastery criterion for all mands in one to three 10-trial training blocks. Fig. 3 shows that by the 18th block, Jenny demonstrated at least 80% accuracy for the mands using manual sign. The figure also shows that

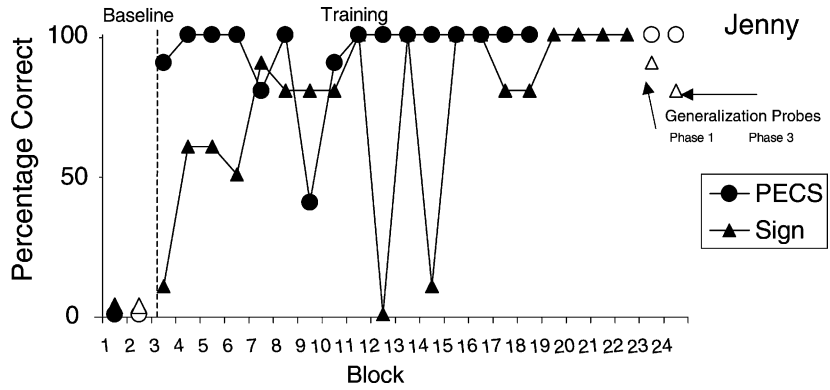

Fig. 3. The percentage of trials correct per block during baseline, training, and generalization probe sessions for Jenny. Data are plotted separately for P.E.C.S. and sign.

Jenny performed with 90% accuracy during the Phase 1 generalization probe, and 80% accuracy during the Phase 3 generalization probe using manual sign.

2.1.4. Mandi

As shown in Fig. 4, Mandi was not able to mand for any of the items using P.E.C.S. during baseline, either at the developmental training center or at her residence. Table 1 shows that Mandi demonstrated mastery criterion during Phase 1 of P.E.C.S. training in one 10-trial block for the first two mands. In Phase 2, she also attained criterion performance for the first two mands in one block each. Midway during training, Mandi acquired an infectious disease and was hospitalized so that neither P.E.C.S. nor sign training could continue.

As shown in Fig. 4, Mandi was not able to mand for any of the items using manual sign during baseline, either at the developmental training center or at her residence. Table 1 shows that Mandi did not demonstrate mastery criterion with any of the mands using manual sign, although Fig. 4 does show some improvement in accuracy relative to baseline.

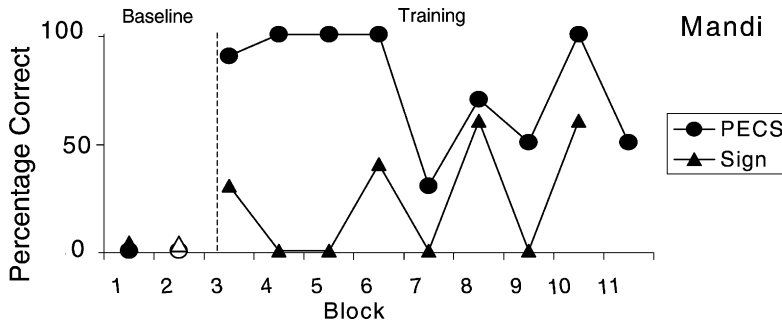

Fig. 4. The percentage of trials correct per block during baseline, training, and generalization probe sessions for Mandi. Data are plotted separately for P.E.C.S. and sign.

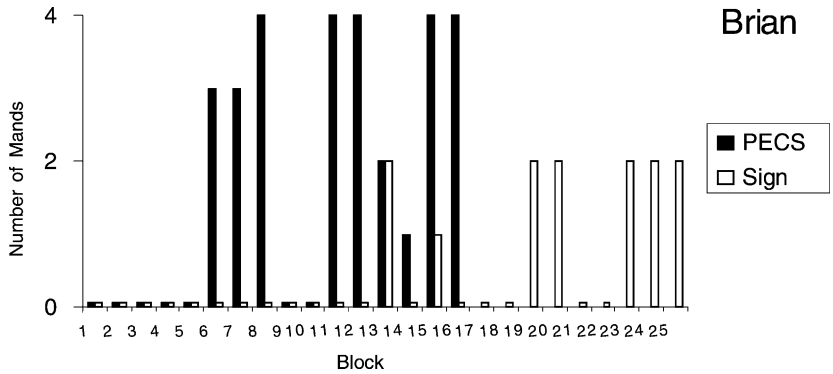

Fig. 5. The number of mands emitted for items out of view per training block for Brian. Data are shown separately for mands using P.E.C.S. and for mands using sign.

2.2. Mands for items out of view

2.2.1. Brian

Fig. 5 shows that the number of mands for items not in view emitted per block using P.E.C.S. increased from zero to four over the course of training. The figure also shows that the number of mands for items not in view emitted per block using manual sign increased from zero to two over the course of training. The number of mands emitted for items not in view is shown for sign only during the final blocks on the figure because Brian had completed P.E.C.S. training by this time.

2.2.2. Chris

Fig. 6 shows that the number of mands for items not in view emitted per block using P.E.C.S. increased from zero to four over the course of training, and that mands for items not in view were emitted using P.E.C.S. given every opportunity beginning with the third training block. The figure also shows that Chris did not emit any mands for items not in view using manual sign over the course of training.

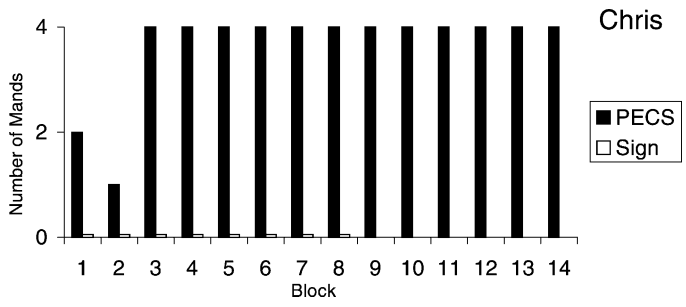

Fig. 6. The number of mands emitted for items out of view per training block for Chris. Data are shown separately for mands using P.E.C.S. and for mands using sign.

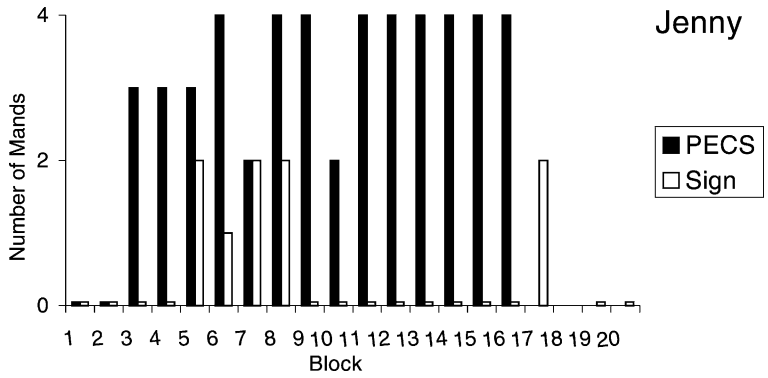

Fig. 7. The number of mands emitted for items out of view per training block for Jenny. Data are shown separately for mands using P.E.C.S. and for mands using sign.

2.2.3. Jenny

Fig. 7 shows that the number of mands for items not in view emitted per block using P.E.C.S. increased from zero to four over the course of training. The figure also shows that Jenny emitted mands for items not in view using manual sign sporadically over the course of training. The number of mands emitted for items not in view is shown for sign only during the final blocks on the figure because Jenny had completed P.E.C.S. training by this time.

2.2.4. Mandi

Fig. 8 shows that the number of mands for items not in view emitted using P.E.C.S. increased from zero to four over the course of the nine P.E.C.S. training blocks that Mandi completed. The figure also shows that the number of mands emitted for items not in view using manual sign increased from zero to three blocks over the course of the eight manual sign training blocks that Mandi completed.

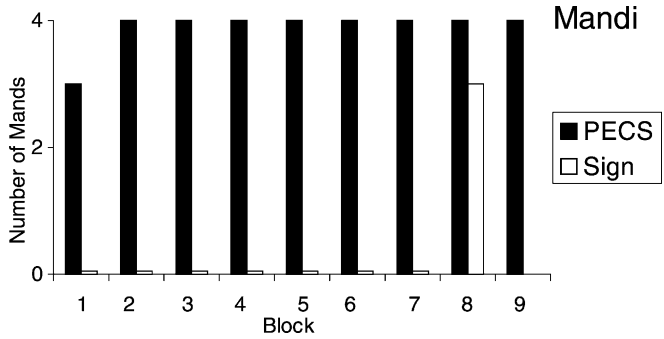

Fig. 8. The number of mands emitted for items out of view per training block for Mandi. Data are shown separately for mands using P.E.C.S. and for mands using sign.

3. Discussion

The results of this study demonstrate that adults with mental retardation in the severe and profound range can successfully acquire mand skills following training with both P.E.C.S. and manual sign. Two of the four participants successfully completed both P.E.C.S. and manual sign training. For three of the four participants, fewer training blocks were required to acquire mands for four items using P.E.C.S. than using manual sign. The data for the fourth participant suggested that she would have also attained mastery criterion with P.E.C.S. first. Three participants also demonstrated the generalization of mands across settings using P.E.C.S. All four participants were more likely to mand for items out of view using P.E.C.S. than using manual sign. Chris and Mandi, who failed to acquire mands using manual sign, spent the most time in Phase 1 of sign training. Despite the fact that pilot research showed that they were able to imitate other signs and gestures, both participants exhibited considerable difficulty imitating the modeled signs. Learning manual sign may require a more developed imitative repertoire than these participants possessed (see Frost & Bondy, 1994).

Although overall these results suggest that training with P.E.C.S. was more effective in establishing mand skills, two participants did acquire the ability to mand for four items using manual sign, and the number of training blocks was not substantially greater. The same two participants also showed the generalization of mands across settings using manual sign. In fact, it is possible that P.E.C.S. training was slightly more effective for Brian and Jenny because attempts to sign for desired items were blocked during P.E.C.S. training. Hence, manual sign may be an appropriate alternative communication form for individuals with more advanced imitative skills, particularly in settings where staff shortages prevent the material preparation and upkeep that is required for P.E.C.S.

This study has several drawbacks. First, although all participants' picture binders were made available to them at their developmental training center and place of residence following mastery, no assessment was made of their manding abilities over the course of ongoing daily activities. This would have made it possible to infer which of the two communication systems was preferred by each participant. Second, some investigations of P.E.C.S. with children have shown increases in vocalizations and eye contact (Bondy & Frost, 1994; Liddle, 2001; see also Anderson, 2002). These changes were not recorded in this study, primarily because the goal was merely to provide adults with some means of functional communication, but it may be important to investigate whether such changes can be established in adults as well as children. Third, assessing the reduction in training time for new mands relative to mastered mands may have also been important. Fourth, although generalization of mand skills to the participants' residence was assessed, a demonstration of the generalization of these skills to community settings would also have been valuable. Future research might evaluate the long-term maintenance of mands acquired using P.E.C.S. and sign, as well as the satisfaction of staff and other caregivers with the training conducted using each system.

One reason P.E.C.S. may have been acquired more rapidly is because of the discriminative functions possibly served by the pictures or binders. During sign trials, there were no distinct discriminative stimuli present (aside from the reinforcing item) to occasion a correct response. This distinction may especially account for the discrepancies in the number of mands for out of view items observed for the two communication forms. In the absence of any distinct discriminative stimuli, emitting the correct sign for a preferred item may be very cognitively demanding. A second reason that mands using P.E.C.S. may have been acquired more rapidly is because a mand response using P.E.C.S. requires a simultaneous discrimination: an individual must first visually scan the pictures and select the picture of the desired item, then place the picture in the hand of a caregiver. Manding with P.E.C.S. may be regarded as a recognition task. Manual sign, on the other hand, may be regarded as a recall task, as participants are forced to recall the modeled prompt before responding on a given trial. For individuals with significantly impaired intellectual functioning, a recall task may be considerably more demanding than a recognition task. A third reason P.E.C.S. may have been acquired more rapidly is because the topography of each mand was identical, whereas the topography of each mand for manual sign was different (see Sundberg & Sundberg, 1990).

In conclusion, training time, generalization across settings, and the likelihood of mands for out of view items, are important variables to consider when selecting a communication form for adults with severe developmental disabilities. Examining generalization across multiple settings and communication partners is crucial to ensure that the skills an individual acquires can be used in a functionally relevant manner. Other variables to consider include the level of preexisting staff knowledge of a particular communication form, as well as the responsibilities staff will have in maintaining the particular system. Although the decision must be unique to each individual, it is hoped that this study will provide helpful information for those evaluating their options.

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