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Effects of iconicity on requesting with the Picture Exchange Communication System in children with autism spectrum disorder

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Abstract

Research on graphic symbol learning suggests that symbols with a greater visual resemblance to their referents (greater iconicity) are more easily learned. The iconicity hypothesis has not yet been explored within the intervention protocol of the Picture Exchange Communication System (PECS). Within the PECS protocol, participants do not point to a symbol but exchange the symbol for an object. The purpose of this study was to examine whether children learn to request more readily with PECS when the symbols involved are highly iconic versus symbols that are low in iconicity. An adapted alternating treatments design combined with a multiple baseline design across subjects was used to evaluate the effectiveness and efficiency of symbol learning under two conditions: high iconicity and low iconicity. Four students with autism or pervasive developmental disorders between the ages of six and nine years participated. Results indicated that students learned to request desired objects under both conditions, lending further support for the effectiveness of PECS. There was little to no difference, however, in the effectiveness and efficiency of requesting between the two conditions during Phases I and II of PECS training. Thus learners do not benefit from symbols that bear more resemblance with their referents during the first two phases of PECS instruction.

Keywords: Augmentative and alternative communication; Autism spectrum disorders; Iconicity; Picture Exchange Communication System; Requesting; Symbol selection

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By definition, individuals with autism spectrum disorder (ASD) exhibit deficits in the development of expressive communication (American Psychological Association, 1994). An estimated 50% of children diagnosed with autism fail to develop functional speech (Peeters & Gillberg, 1999). As a result, many children diagnosed with ASD receive specific instruction in the use of augmentative and alternative communication (AAC) strategies. AAC intervention techniques may involve gestures, manual signs, graphic symbols, communication boards, and/or speech generating devices (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997). One benefit of these strategies for persons with autism is that AAC tends to provide a visual component to language, which is reported to be consistent with the learning style of many individuals with autism (e.g., Ogletree & Harn, 2001). There are many symbol sets and systems available that provide graphic representations of vocabulary, and clinicians working with clients who use AAC are required to select the symbol set or system most appropriate for an individual. Symbol learnability plays a large role in the selection of a symbol set/system or individual symbols for an individual, and one variable that is documented to affect the learnability of graphic symbols is iconicity (Lloyd & Fuller, 1990). Iconicity can be defined as the visual resemblance between a symbol and its referent, or as "an association that an individual forms between a symbol and its referent" (Schlosser & Sigafoos, 2002, p. 103; see also Lloyd & Fuller, 1990). Degree of iconicity is often described on a continuum, with symbols that are highly iconic labeled as transparent, symbols that are moderately iconic labeled as translucent, and symbols with little to no resemblance to their referent labeled as opaque (Fuller, 1997).

Previously researchers have investigated the degrees of iconicity of available symbol sets/systems with typically developing children and adults. For example, Bloomberg, Karlan, and Lloyd (1990) investigated the translucency, or degree of visual representation, within and across five commonly used symbol sets/systems: Blissymbols, Picsyms, Pictogram Ideogram Communication Symbols (PIC), Picture Communication Symbols (PCS), and Rebus. Fifty college undergraduate students rated the level of iconicity of 15 nouns, 14 verbs, and 12 modifiers from each of the five symbol sets/systems on a seven-point Likert scale. The authors found that symbols in the Rebus and PCS sets were the most translucent overall, and nouns were the most translucent class across the five symbol sets and systems. Verbs were found to be more translucent than modifiers in the three symbol sets (Rebus, PCS, and PIC), while verbs and modifiers received equal translucency values in the Picsyms and Blissymbols. These results supported previous work done by Mirenda and Locke (1989), who investigated the relative transparency of symbols from 11 symbol sets and systems. Subjects included 10 children with autism and varying degrees of cognitive impairment, as well as 30 children and adults with a variety of medical diagnoses, varying degrees of cognitive impairment, and varying speech and language abilities. These authors identified the following hierarchy of symbol iconicity, listed from most to least transparent: objects, color photographs, black and white photographs, miniature objects, black and white line symbols (Picsyms, Self Talk, PCS, and Rebus, in that order), Blissymbols, and written words.

Literature on iconicity often refers to the iconicity hypothesis, which states that symbols with greater degrees of iconicity are more easily learned (Hurlbut, Iwata, & Green, 1982; Koul, Schlosser, & Sancibrian, 2001; Schlosser & Sigafoos, 2002; Sevcik, Romski, & Wilkinson, 1991). There is a significant body of research that documents the application of the iconicity hypothesis to graphic symbol learning in individuals with and without disabilities (e.g., Fuller, 1997; Koul & Lloyd, 1998; Mizuko, 1987; Mizuko & Reichle, 1989). This literature supports the iconicity hypothesis within the same graphic symbol sets/systems (i.e., more iconic Blissymbols are learned more readily than less iconic Blissymbols) and across graphic symbol sets/systems (e.g., PCS tend to more iconic and also learned more readily then Blissymbols). These studies have in common that they assessed iconicity a priori and then either manipulated the degree of iconicity within a graphic symbol set before examining its effect on learning or they selected sets/systems of varying iconicity and studied their effects on learning. Kozleski (1991) and Hurlbut et al. (1982) aimed to examine different symbol sets/systems and evaluate its effects on requesting. However, these studies offered the iconicity hypotheses as a post-hoc explanation of differential learning and therefore cannot adequately address the iconicity hypothesis (Schlosser & Sigafoos, 2002).

Studies that manipulated iconicity apriori as an independent variable (Fuller, 1997; Koul & Lloyd, 1998; Mizuko, 1987) have required participants to point to a symbol among an array of symbols following an instructional mand (e.g., point to _____[word referent]) in order to measure symbol learning. Therefore, none of these studies examines the role of iconicity within an exchange-based communication system such as the Picture Exchange Communication System (PECS) (Frost & Bondy, 1994). PECS is a symbol exchange system that was developed to teach children with ASD ‘‘a rapidly acquired, self-initiated functional communication system’’ (Bondy & Frost, 2001, p. 727). Training begins by identifying a child’s highly preferred and motivating items. It teaches them to request these items with graphic symbols, using specific physical prompting and reinforcement techniques during each phase. PECS training is laid out in six phases, and trainers are instructed to advance to the next phase when a learner has reached 80% independence on exchanges within a phase. In *Phase I: Physical Exchange*, children are trained to exchange a graphic symbol for a desired object. *Phase II: Expanding Spontaneity*, teaches an individual to exchange a symbol with a communication partner who is not in his or her immediate vicinity. In *Phase III: Picture Discrimination* the child learns to discriminate between symbols to request preferred objects. Then, in *Phase IV: Sentence Structure*, the learner is taught to apply an ‘‘I want’’ symbol to a blank sentence strip, along with the symbol for a desired object, and to exchange the sentence strip with a communication partner. *Phase V*: *Responding to ‘‘What do you want,’’* teaches a learner to respond to a direct question. Finally, *Phase VI*: *Responsive and Spontaneous Commenting* builds upon acquired skills to encourage a response to additional questions (i.e., ‘‘What do you see?’’) and spontaneous commenting.

Several controlled studies have investigated the effectiveness of PECS instruction in children with autism (Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Sigafoos, Ganz, O’Reilly, Lancioni, & Schlosser, 2006; Son, Sigafoos, O’Reilly, & Lancioni, 2006; Tincani, 2004; Yoder & Stone, 2006a, 2006b). While the above studies speak to the effectiveness of PECS in terms of requesting and/or speech production in children with autism, very little systematic research has been conducted into the variables that might influence PECS acquisition. Participant characteristics may represent one group of such variables. In perhaps the only study of its kind, Yoder and Stone (2006b) found that PECS participants with initially high object exploration used more different nonimitated words during treatment follow-up than high exploration counterparts participating in Responsive Education and Prelinguistic Milieu Teaching (RPMT) training. In contrast, RPMT participants with low object exploration demonstrated more different nonimitated words than low exploration PECS peers. These authors concluded that this co-variance might provide direction in the selection of treatment approaches. That is, children with high object manipulation abilities may be better candidates for PECS, while those with low object manipulation may have better outcomes with RPMT.

The iconicity of the selected symbols might be another variable that may influence PECS acquisition; clinicians can select symbols accordingly in order to maximize acquisition. Although the PECS manual does not explicitly state that iconic symbols should be selected, they do recommend PCS (which has been found rather iconic relative to other sets/systems in previous iconicity research) because "of the wide variety of pictures available" (Frost & Bondy, 1994). This recommendation seems to have been followed in all controlled PECS studies to date by relying exclusively on PCS.

Iconicity research has relied on the participants to scan an array of symbols and to point to one target symbol. Typically, there are no objects involved and the student is not taught to request. This is different from PECS instruction where the learner brings a card with a symbol on it to the partner and exchanges it for the requested object. The focus of PECS, in Phases I and II, is deliberately not to begin with symbol identification, symbol discrimination, and matching of the symbol to the object. Therefore, it is unknown to what extent, if at all, learners examine the relation between symbol and referent—a precondition to benefiting from iconicity. It is thus unclear whether support for the iconicity hypothesis generalizes to these different task demands during PECS instruction. If learners were to benefit from iconicity, practitioners would have a data-based rationale for selecting such symbols for PECS instruction. On the other hand, if learners did not benefit from iconicity, this may open the door to the selection of more abstract symbols that do not lock the learner into image-based referents, which may impede generalization to exemplars that do not look like the symbol.

Thus, the current study sought to answer the following research question: Does iconicity impact requesting as a result of PECS instruction, and does the role of iconicity vary with the specific instructional phase within the PECS protocol? Specifically, although our aim was to examine this question across Phases I–III, Phase III could not be completed for all participants due to school holidays. Hence, we will restrict our discussion of the implications only to the first two phases.

1. Method

1.1. Participants

Four children between the ages of 6 and 10 with a diagnosis of autism or Pervasive Developmental Disorder (PDD) participated. A licensed psychologist, pediatrician, or neurologist diagnosed the children according to the criteria set forth by the Diagnostic and Statistical Manual: Fourth Edition (DSM-IV). Additionally, participants had to meet the following criteria: (a) have little to no functional speech (no more than 10 spoken words), (b) rely primarily on pre-linguistic means of communication (i.e. pointing, leading), (c) be considered candidates for PECS by their clinical team or primary speech-language pathologist and (d) no history of systematic instruction in requesting with graphic symbols (all children had little to no previous exposure to requesting with graphic symbols although some participated in classrooms in which other students used graphic symbols to request). Students, who met these criteria were identified by the clinical team at a school for children with developmental disabilities in Massachusetts. Information flyers and consent forms were provided to parents of potential participants. Five students were originally enrolled in the study; however one student was excluded following baseline measurement due to consistent bias toward one experimental condition. Specific characteristics for each participant, as reported in a current Individualized Education Plan (IEP), are provided in Table 1.

1.2. Setting

All sessions took place in a private assessment suite within the students' school. During Phases I and III instruction sessions and probes, students were seated across from the experimenter at a

Table 1
Participant Information

Student	Age	Diagnosis	Receptive communication skills	Current means of requesting
James	9	PDD-NOS	Follows one and two-step familiar directions	Leading communication partners to objects
Henry	7	Autism	Follows one-step familiar commands in the classroom	Pointing, reaching, leading adults to objects, modified sign to indicate ''more''
Peter	6	PDD	Responds to his name and follows routine one-step directions	Gestures, leading adults to desired objects, modified sign ''more''
Phillip	8	Autism	Follows a few one-step familiar directions	Facial expressions, gestures, a few sign approximations

rectangular table in a small assessment room. Phase II instruction sessions and probes took place in the adjoining waiting area of the assessment suite. This was a rectangular area directly outside the assessment room with two couches, two tables, and a set of bookshelves. The waiting area provided the necessary space to teach the Phase II distance exchange.

1.3. Stimulus materials

Eight preferred items were identified for each student as detailed in the experimental procedures. Items selected were represented in the symbol vocabularies of PCS and/or Blissymbols. Several specific items that did not appear in the symbol dictionaries were represented by more general symbols. For example, the symbol for ''cereal'' was used to represent ''Cheerios'' and the symbol for ''candy'' was used to represent ''jelly bean.'' Each object was assigned to one of two experimental conditions (see Experimental Design): PCS or Blissymbols served as stimuli. Symbols in both conditions were $2'' \times 2''$ in size and printed in black-and-white. Symbols were laminated for durability, and Velcro was applied to the underside of each symbol for ease of storage. A small three-ring binder was constructed for each student with Velcro applied to each page and the cover of the binder for symbol storage and presentation.

1.4. Experimental design

An adapted alternating treatments design (AATD) (Sindelar, Rosenburg, & Wilson, 1985) was utilized to compare the efficacy of PECS training with PCS versus PECS training with Blissymbols. Four objects and their corresponding symbols were assigned to each experimental condition and were matched for preference and comprehension across conditions. Once a pair was matched, the experimenter assigned the object and symbol at random and blinded to either condition. Presentation order was counterbalanced across conditions to control for potential order effects. The AATD was embedded in a multiple baseline across participants design in order to rule out common threats to internal validity.

1.5. Dependent measures

The percentages of correct requests per session and the number of sessions to criterion were measured for each condition during baseline and each phase of PECS instruction (Phases I–III). The criterion for advancement within a phase was set at 80% independence on symbol exchanges made during PECS instruction, as suggested in the PECS Training Manual (Frost & Bondy, 1994). Mastery criterion for each phase was set at 100% correct exchanges made during two consecutive daily probes. During baseline and Phase I of PECS instruction, a correct request was recorded when the student removed the target symbol from the table and independently released it into the experimenter's hand. The experimenter's hands remained crossed on the table until the student reached past the object with the symbol. One hand was then rotated palm-up to accept the symbol from the student. For baseline and daily probes, an incorrect response was recorded if the student attempted to obtain the target object without regard to the corresponding symbol, if the student relied on pre-linguistic means (i.e. gestures or leading) to request the target object, or if the student manipulated but did not exchange the symbol. During Phase II, a correct response required the learner to remove the target symbol from the cover of his communication book, independently walk to the experimenter, and release the symbol into the experimenter's hand. During Phase III, a correct request was recorded if the learner independently selected the symbol that corresponded to the object from an array of symbols and presented and released it into the experimenter's hand. During Phase III, an incorrect response was recorded if the learner selected a symbol that did not correspond to the target object or if the correct symbol was selected but not exchanged with the experimenter. During intervention, a prompted response was recorded when the student required a gestural prompt (i.e., an open hand cue) or physical assistance to exchange the target symbol. Data were recorded for three points of exchange during each intervention trial: symbol selection, initiation of exchange, and symbol release.

1.6. Procedures

1.6.1. Preference assessment

Parents and teachers were interviewed to identify 20–25 preferred items for each participant. Caregivers and educators were asked to list leisure and edible items that the student preferred, but to omit items that would likely cause the child to tantrum when the object is withdrawn. Items not found in the symbol dictionaries of PCS and Blissymbols were omitted. A systematic preference assessment was then conducted, during which the remaining items were presented to each participant individually. The student was given five seconds to select and manipulate the object. Objects were presented five times consecutively. Based on the work of Pace, Ivancic, Edwards, Iwata, and Page (1985), items selected in 80% of trials were considered preferred. In order to determine the relative degree of preference for each object, preferred items were arranged in groups of three or four. In the initial trial, all items in a group were presented on a table in a horizontal row in front of the student, and the student was permitted to select and manipulate one object. Once manipulated, this object was removed from the subsequent trials. In the second trial, the remaining objects were presented, and this procedure was continued until all objects had been selected. Relative preference was determined by calculating the percentage of selections per selection opportunity. Preference assessments were conducted across two sessions for each participant. Items assigned to each experimental condition (PCS and Blissymbols) were matched for degree of preference.

1.6.2. Object word comprehension assessment

A comprehension assessment was conducted for each preferred object. As reviewed earlier, research suggests that symbols that bear a greater resemblance with their referent are more easily learned by individuals with and without disabilities. However, Sevcik et al. (1991) suggested, "if individuals do not have a particular semantic concept within their linguistic repertoires, then that meaning would not be able to be employed to facilitate learning of a symbol'' (p. 163). In other words, if a learner does not comprehend a word for a particular object or concept, this could impact symbol learning. Therefore, items assigned to experimental conditions in this study were matched for object comprehension in order to control for the potential impact this may have on symbol learning. For the purpose of determining object word comprehension, preferred items were presented four at a time (one target object and three other preferred objects in each trial). The student was instructed to ''Point to *target*'' or ''Give *target*.'' A correct response was recorded if the learner exchanged, touched, reached, or pointed to the target object. Each response was recorded as correct or incorrect, and each object was targeted in four trials, with the position of the objects varied across trials. The number of correct identifications for each object was divided by the total number of trials for that object and multiplied by 100 in order to calculate the percentage of correct identifications for each object.

1.6.3. Iconicity preassessment

Eight to ten highly preferred items were identified for each participant according to the procedures detailed above. Items were matched for preference and comprehension and assigned to one of two experimental conditions: PCS or Blissymbols. Although previous studies have revealed that PCS has greater translucency than Blissymbols in general, it was necessary to obtain iconicity ratings for the specific symbols selected for this study. Therefore, all symbols were compiled into a booklet and presented to 74 high school juniors and seniors who had little to no previous familiarity with graphic symbols. The procedures used by Lloyd, Karlan, and Nail-Chiwetalu (1994) were followed. Thirty percent of the symbols (15% of PCS and 15% of Blissymbols) appeared twice in the stimulus booklet, to allow for a measure of reliability in the iconicity ratings. Six $2'' \times 2''$ black-and-white symbols were presented in two columns on each stimulus page. A printed label appeared below each symbol, and participants were asked to circle a rating for the translucency of each symbol on a seven-point Likert scale. A rating of 1 indicated very little visual relationship between the symbol and its referent, and a rating of 7 indicated a very strong visual relationship. The numbers 2–6 represented a continuum between very little and a very strong relationship. The cover page of each booklet displayed directions for the task, which were read to the participants, and space for the collection of demographic information from the students. Four sample items were reviewed via an overhead projector prior to administration of the booklet. Students' questions were answered before they began the task.

Following administration, mean iconicity scores were calculated for each symbol and for each experimental condition (mean PCS rating and a mean Blissymbol rating). For repeated items, each participant's number of agreements were totaled, divided by the total number of repeated items, and multiplied by 100 to calculate the percentage of agreement among items for each rater. Responses from raters with less than 80% reliability were omitted from the final ratings. Responses from 48 participants were averaged to obtain final iconicity ratings. The average rating for PCS symbols was 6.36, and the average rating for Blissymbols was 2.18. The average iconicity rating for each symbol is displayed in Appendix A.

In order to effectively manipulate the variable iconicity for this requesting study, it was necessary that stimulus symbols in the PCS condition be more iconic than those in the Blissymbols condition. Therefore, to form the stimulus sets for PECS instruction, a Blissymbol with an average iconicity score greater than the to-be-paired PCS symbol was omitted. This was rare, but it did occur in a few situations. For example, the Blissymbol ''ball'' received an average iconicity rating of 5.1, whereas the PCS symbol ''beads'' received an average rating of 4.72. Therefore, the Blissymbol ''ball'' was omitted from the stimulus materials and replaced with an equivalent item that received a lower iconicity rating. As a result, the final stimulus sets for each student included four symbols assigned to each experimental condition and matched for preference and comprehension. For each student, all of the PCS symbols received higher ratings than all of the Blissymbols.

1.6.4. Baseline

In order to obtain a baseline measure of requesting, all four selected objects in each condition were presented individually to the learner. The corresponding symbol was placed on the table between the learner and the object, but the learner was not given any physical, verbal, or gestural prompts to use the symbol. A correct request was recorded if the student removed the symbol from the table within the allotted 15 s, and released it into the hand of the experimenter. An incorrect request was recorded if the learner attempted to obtain the object without regard to the graphic symbol, manipulated the symbol but did not exchange it, or employed a pre-linguistic means to request the object (i.e., pointed to the object). After the 15-s interval expired, regardless of the accuracy of the response, the learner was permitted 30 s to manipulate each object. The number of correct requests was divided by the total number of opportunities for each condition and multiplied by 100 to obtain a baseline percentage of correct requests. The presentation order of the two experimental conditions was counterbalanced across sessions, while the presentation order of the symbols was randomized within conditions, in order to avoid a potential bias of presentation order.

In accordance with the multiple baseline design across participants, baseline data were collected in a staggered manner. Specifically, baseline data were collected across four sessions for participant one, nine sessions for participant two, eleven sessions for participant three, and thirteen sessions for participant four. After the initial two baseline measurements, it was revealed that four of the five participants achieved greater than 80% correct requests for Phase I baseline probes without any instruction. At that point, baseline probes were administered for Phases I–III simultaneously to establish a stable baseline measure for subsequent phases. Phase II baseline probes began with the student standing 5 m from the communication book, with one symbol placed on the cover of the book. The corresponding object was placed near the communication book, within the student's eyesight, but out of his reach. The experimenter stood an additional 5 m from the communication book. A correct response was recorded if the student independently walked to the communication book, obtained the symbol, and walked the additional five meters to exchange it with the experimenter. All other responses were recorded as incorrect. The student was given thirty seconds to complete this exchange in order to obtain the desired object. The trainer stood facing the target symbol during probes, but no other verbal or visual cues were given to the learner. During Phase III baseline probes, the learner and experimenter were again seated across from one another at a table, and the communication book was positioned between them, facing the learner. All four symbols from one condition, Blissymbols or PCS, were placed on the cover of the student's communication book, with two symbols on the top row and two on the bottom. The target objects in this condition were then presented individually. An object was placed on the table between the trainer and the communication book, and the student was given 15 s to remove the corresponding symbol from the communication book and release it into the trainer's hand. The trainer's hands remained crossed, with palms facing down, on the table until the student moved the symbol past the target object. The trainer's right hand was then rotated (palm-up) to accept the symbol from the learner. No verbal or gestural cues were given. A correct response was recorded when the learner independently exchanged the symbol that corresponded with the object presented. An incorrect response was recorded if the student removed a symbol but did not exchange it, exchanged an incorrect symbol, or attempted to exchange multiple symbols.

1.6.5. PECS intervention

PECS instruction was carried out for each of the eight preferred objects according to the PECS Training Manual (Frost & Bondy, 1994). Instruction sessions took place three to five times per week for approximately 15–30 min per session. A five-minute break was provided as needed between training conditions. Each training session consisted of one trial per target object for Phases I and II, and two trials per target during Phase III.

During instruction in *Phase I: The Physical Exchange*, the participant was seated at a table facing the experimenter, with an aide standing behind the student. Each of the preferred objects was presented individually, and the corresponding symbol was placed on the table between the student and the target object. Initially, the student was physically prompted with hand-over-hand assistance by the aide to remove the symbol from the table and release it into the open hand of the experimenter. The physical assistance and open hand cue were faded throughout training until the student independently removed the symbol from the table and presented it to the experimenter.

During *Phase II: Expanding Spontaneity*, symbols were presented individually on the cover of the student's communication book, and the distances between the trainer and the symbol and between the student and the target symbol were gradually increased (up to 5 m) as outlined in the PECS Training Manual. The goal of this phase was for the student to walk to the table, remove the symbol from the cover of his communication book, walk five additional meters, and release the symbol into the trainer's hand. Initially, the student was seated at a table in front of the communication book, and the trainer (experimenter) stood 1 m in front of the table. The student was provided with hand-over-hand assistance according to a progressive time delay until he exchanged the symbol with 80% independence. For example, the student received immediate physical assistance to exchange the symbol during the initial instruction session. During the second instruction session, the aide waited one second before providing physical assistance. This delay was increased up to fifteen seconds. When the initial distance was mastered at 80% independence, the student began the session standing 1 m from the communication book and was physically prompted to walk to the book, obtain the displayed symbol, and bring it to the trainer. These distances continued to be increased in increments of one meter, until the student independently walked five meters to obtain a symbol and five additional meters to exchange it with the experimenter.

According to the PECS Training Manual, *Phase III: Picture Discrimination* requires the student to select contextually appropriate symbols from inappropriate foils (Frost & Bondy, 1994). However, in order to focus on the target symbols for the purposes of this study, the student was again presented with the eight preferred items individually. In each trial, two graphic symbols from PCS and Blissymbols, respectively, were presented on the cover of the communication book, one of which was the target symbol. The learner received hand-over-hand assistance to select the symbol that corresponded with the object presented. Prompts were gradually faded according to a progressive time delay, and trials continued in this manner until the learner correctly discriminated between the two symbols independently in 80% of instruction trials. Additional symbols were then added one at a time until the student correctly discriminated between all four symbols in each condition. Since the student was prompted by the presence of the target object, correspondence checks were not necessary to ensure intentionality of requests. The order of the conditions was alternated between each

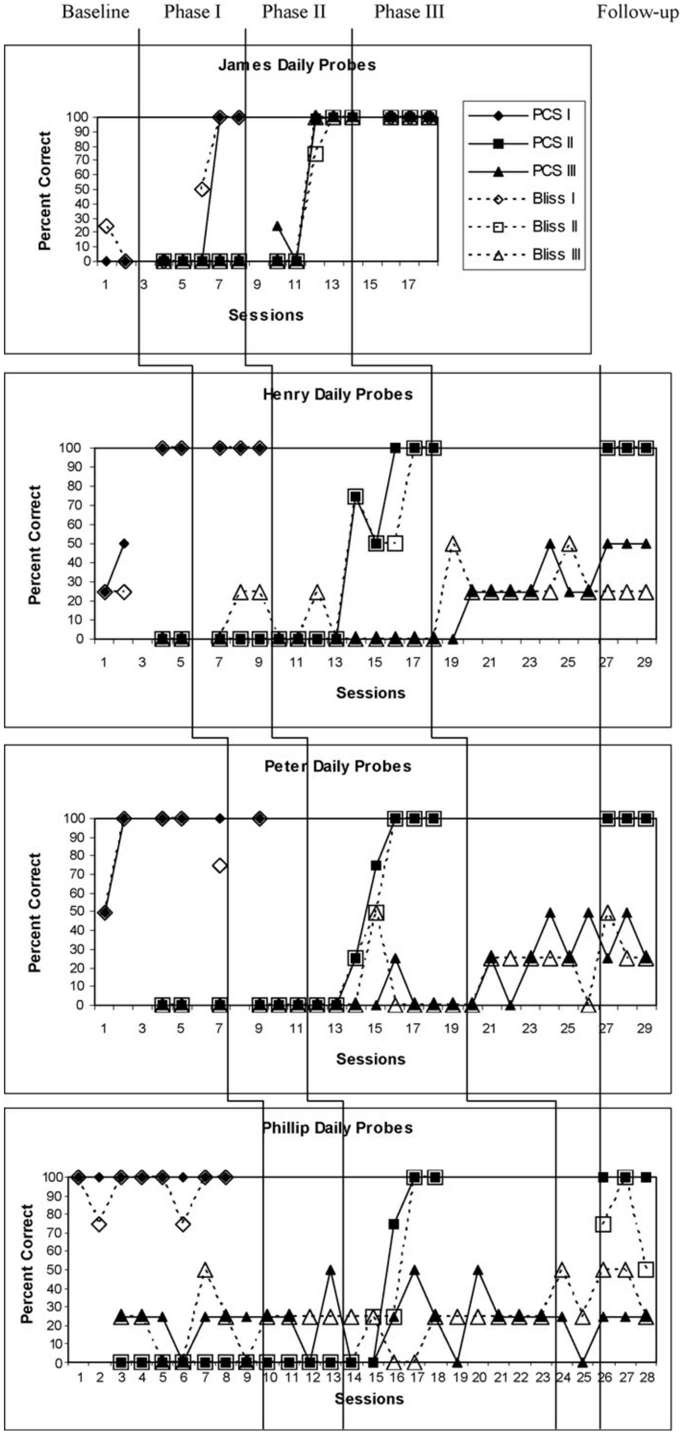

Fig. 1. Percentage of correct requests made by participants during baseline, daily, and follow-up probes. Baseline segment indicates the duration of Phase I baseline. Phases II and III baseline sessions continued until training began for each phase.

session. Symbol positions were varied by trial in order to avoid position learning and encourage discrimination.

1.6.6. Daily probes and follow-up probes

Throughout the intervention phase, daily probes were administered on alternating days to measure the students' learning. As students began Phase III instruction, acquisition probes were conducted prior to each training session to monitor progress more closely. Follow-up probes were conducted 1 week subsequent to the termination of instruction. For each phase, procedures for daily probes and follow-up probes were identical to the baseline probes in that phase.

1.7. Inter-observer agreement

An independent graduate research assistant (RA) collected inter-observer agreement (IOA) data during 20–30% of daily probes and intervention sessions. The RA was trained in the procedures of the study prior to observations. IOA was calculated by dividing the number of agreements by the number of agreements plus disagreements, multiplied by 100. IOA was 100% for probes and intervention data across both conditions. An independent observer collected treatment integrity data during 20–25% of acquisition probes and intervention sessions. This was to ensure the fidelity of instruction and testing in both conditions (Schlosser, 2002), The independent observer recorded adherence to protocol on the set-up, prompts, symbol exchange, reinforcement, and data collection during intervention and daily probes. Treatment integrity ranged between 96.6% and 100% during acquisition probes, with a mean of 99.8% across all sessions. Treatment integrity for intervention sessions ranged from 98.4% to 100%, with a mean of 99.7% across sessions.

2. Results

Data were plotted graphically to examine the effectiveness and efficiency of symbol learning during three phases of PECS using Blissymbols and PCS. Daily probe results are presented in Fig. 1, and intervention results are reported in Fig. 2 (missing data points are a result of school absences). Specifically, the percentage of correct requests per session and the number of sessions to criterion for each phase of PECS instruction were recorded. All students achieved mastery in Phases I and II of PECS in both conditions. Results are discussed individually for acquisition probes and intervention.

2.1. Participant 1: James

James began intervention at Phase I, as he did not initially exchange symbols independently. He exchanged 0–25% of symbols independently across four baseline sessions. He achieved mastery criterion (100% correct exchanges during probes across two consecutive sessions) for Phase I in both conditions simultaneously after participating in five instruction sessions. Throughout Phase I instruction, James maintained a stable baseline of 0% correct exchanges for Phases II and III probes. Following eight Phase II intervention sessions, James achieved mastery criterion for Phases II and III probes simultaneously in both conditions. As a result, he did not require Phase III instruction. No difference was observed in the effectiveness and efficiency of symbol learning between the two experimental conditions, PCS and

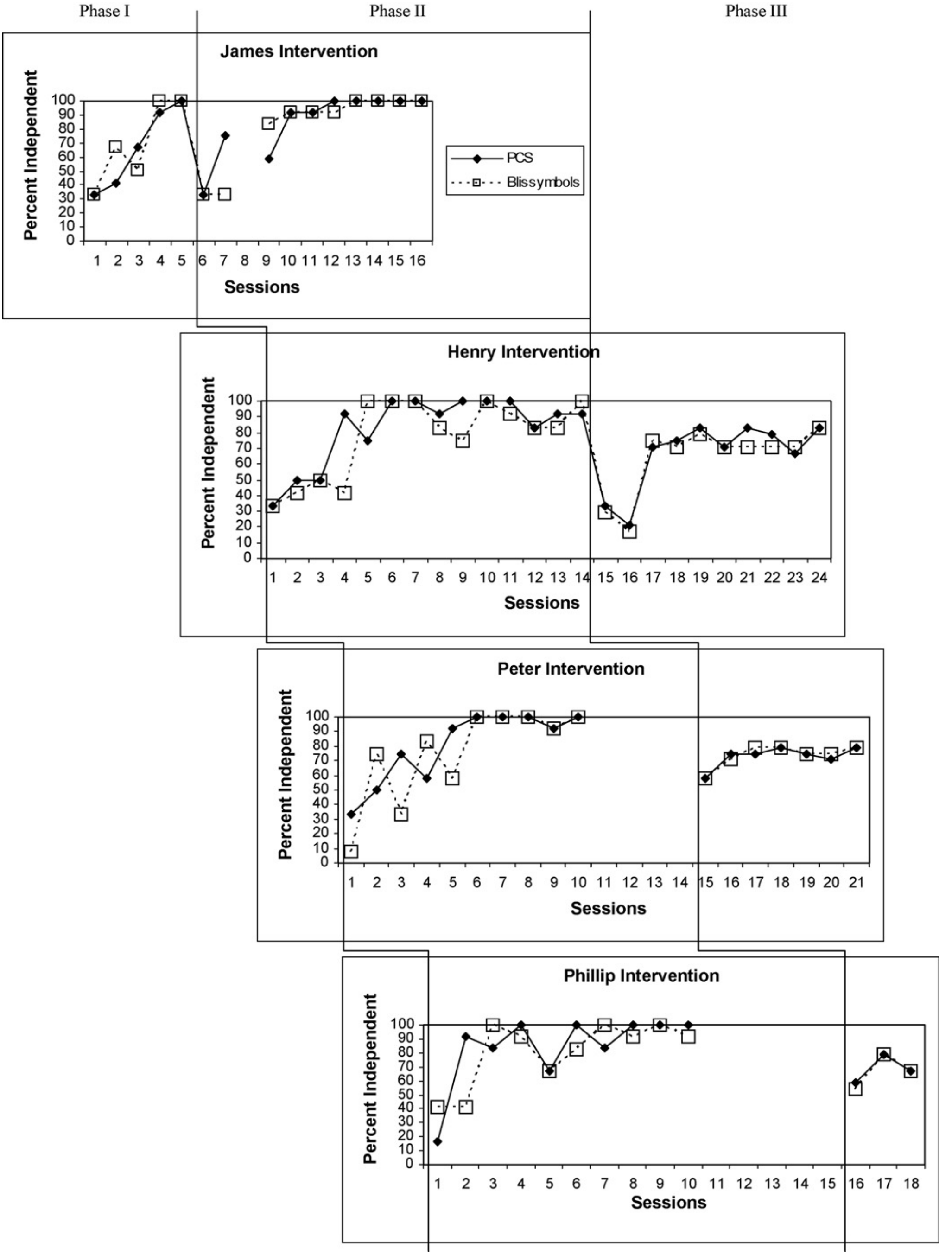

Fig. 2. Percentage of independence on exchanges made by participants during Phases I–III intervention.

Blissymbols. Follow-up probes were conducted one week following completion of Phase II instruction. James maintained 100% correct independent exchanges for all phases across three follow-up probes.

2.2. Participant 2: Henry

Henry achieved mastery of Phase I exchanges during his third baseline session, before he received any instruction. His baseline for Phase II exchanges remained at zero, and Phase III probes were steadily at or below chance level (0–25%). Therefore, instruction began at Phase II, after nine baseline sessions. Henry required 14 instruction sessions to achieve mastery of the Phase II distance exchange. Mastery of Phase II in the PCS condition preceded that of Blissymbols by one session. Phase III training began immediately after Henry reached Phase II criterion. In Phase III discrimination training, Henry immediately rose above his baseline of zero correct exchanges to 25–50% correct exchanges during daily probes. Intervention data show that after five training sessions, Henry discriminated between and exchanged two symbols with 80% independence. According to protocol, a third symbol was added during instruction, and Henry maintained a level of 70–80% independence. Performance on daily probes remained steady at 25–50% correct exchanges in both experimental conditions throughout Phase III intervention. Three follow-up probes were conducted immediately following Phase III intervention. Henry maintained 100% correct exchanges on the Phase II distance exchange. Phase III follow-up probes revealed that Henry correctly discriminated among 50% of the PCS symbols and 25% of the Blissymbols across three sessions.

2.3. Participant 3: Peter

Peter also achieved mastery of Phase I exchanges during baseline, without receiving any instruction. He began intervention at Phase II after eleven baseline sessions. Peter increased from 0% correct exchanges to 100% correct exchanges during Phase II daily probes after ten intervention sessions. Phase II mastery was achieved simultaneously in the two experimental conditions. Peter maintained a relatively stable Phase III baseline throughout Phase II training. After Phase III instruction began, he immediately increased from 0% correct exchanges to 25–50% correct exchanges during daily probes in both conditions. During instruction sessions he consistently discriminated between and exchanged two symbols with 75–79% independence. Follow-up probes were conducted for Phases II and III immediately following termination of Phase III intervention. Probes were collected on three consecutive days. The data show that Peter maintained 100% correct exchanges in Phase II, while he continued to achieve 25–50% during Phase III in both experimental conditions.

2.4. Participant 4: Phillip

Despite having never used an exchange-based method of requesting in the past, Phillip independently exchanged one symbol for one object with 100% accuracy during his initial baseline session. His baseline for the distance exchange (Phase II) was steady at zero, and his Phase III baseline remained primarily at or below chance level (0–25%) over 13 baseline sessions. Phillip occasionally reached 50% correct exchanges during Phase III baseline probes, however the symbols correctly exchanged were not consistent across sessions. Phillip reached mastery of Phase II after 10 instruction sessions in both experimental conditions. He immediately began Phase III discrimination training. Daily probes reveal that Phillip's correct exchanges in Phase III ranged from 0 to 25% per session in the Blissymbols condition. The percentage of correct exchanges was slightly higher in the PCS condition, ranging from 25 to 50%. During instruction, Phillip discriminated between and exchanged two symbols with 54–79% independence, and very little difference was observed in his performance between the two experimental conditions. Follow-up probes were conducted immediately following termination of Phase III intervention. On Phase II probes, Phillip maintained 100% correct exchanges across three sessions in the PCS condition, while the Blissymbols condition ranged from 50 to 100% correct exchanges. Phase III follow-up probes remained between 25 and 50% correct exchanges in both conditions.

3. Discussion

This study adds to the current body of literature documenting the effectiveness of PECS instruction in teaching students with autism/PDD to request using graphic symbols (e.g., Ganz & Simpson, 2004; Tincani, 2004; Yoder & Stone, 2006a, 2006b). The results of this study also showed that participants mastered Phases I and II of PECS with very little difference between the two experimental conditions: PCS and Blissymbols. Three students did not achieve mastery of Phase III (discrimination) before summer holidays started; however they all improved over baseline performance. Although it is not possible to draw definitive conclusions on the effectiveness and efficiency between the two experimental conditions during Phase III training for these three students, it should be mentioned that probe and intervention data are very similar in both conditions for all participants. Phase III follow-up probes showed that one student consistently achieved a greater percentage of correct exchanges in the PCS condition. Phase III probes for the remaining students were more variable in both conditions.

Based on the Phase I and II results, the dogmatic selection of PCS symbols for PECS training may be called into question. All previous studies of PECS have relied only on PCS symbols for instruction. Additionally, the PECS Training Manual (Frost & Bondy, 1994) recommends use of PCS for training. Based on the results of this study, less iconic symbols may be acquired at the same rate as more iconic symbols at least during Phases I and II of PECS training. One of the proposed disadvantages of iconic symbols is that they lock the student into image-based referents, which may impede generalization to exemplars that do not look like the symbol (Sevcik et al., 1991). Hence, the use of less iconic symbols at no cost in terms of acquisition may pay off in terms of facilitating generalization. This, however, needs to be further investigated in future research, to determine whether these results will carry over to Phases III–VI of PECS. Unfortunately, only one participant achieved mastery of symbol discrimination before the beginning of summer vacation. It is possible that with continued instruction, a difference may have emerged between the two experimental conditions. The extent of discrimination training was limited in this study due to time constraints imposed by the school calendar. It could be the case that iconicity ultimately impacts learning only in PECS Phases III–VI. Future studies should focus on the impact of iconicity in learning symbol discrimination, and extend it to subsequent PECS phases. One could argue that iconicity should not play a role in the first two phases of PECS because only in the third phase forward are the learners taught to discriminate among symbols. During Phases I and II of PECS students are taught a specific motor response, namely to obtain a graphic symbol and exchange it for an object. Throughout these two phases, the learner is presented with only one symbol to exchange for one object. In order to achieve mastery in Phases I and II, a student is not in any way required to closely examine a particular symbol. Thus, it is logical that symbol iconicity may not play a major role in learning during the first two stages of PECS. Studies that have investigated iconicity and symbol learning required learners to discriminate between symbols from the onset of instruction by requiring the participants to choose one symbol from a display of many symbols. In this context, it is reasonable that iconicity plays a greater role in symbol learning. Symbol discrimination is the focus of instruction in PECS Phase III.

Given these differences in instruction it may not be surprising that these findings contrast with the majority of literature on graphic symbol learning, which suggests that more iconic symbols are more easily learned by children and adults with and without disabilities (e.g., Fuller, 1997; Mizuko, 1987; Mizuko & Reichle, 1989). In addition to the PECS instruction itself (as discussed above), there are several other plausible explanations for this. First, previous studies that support the iconicity hypothesis have primarily relied on a pointing response to investigate symbol learning, as opposed to an exchange-based system. Thus, one possible explanation for this discrepancy lies in these differences in task requirements. Second, none of the previous studies that investigated the effects of iconicity on symbol learning have monitored requesting as a dependent variable. Rather, in iconicity tasks the learner merely points to a symbol, but this action does not have any communicative purpose. Requesting, on the other hand, is mediated by the object received following the selection (exchange) of the symbol. That is, a learner may not notice or care to examine the resemblance between the symbol and referent as long as the symbol provides access to a desired object (Schlosser & Sigafoos, 2002). Reichle (1991) illustrated this possibility eloquently for manual signs: ‘‘Although translucency of a sign has been shown to influence the rate at which it is acquired, it may not be the single most important factor. The reinforcing value of an item might have a greater effect on the rate at which the corresponding gesture is acquired. That is, a candy bar represented by an opaque gesture might be more easily acquired than a highly guessable gesture for water’’ (p. 54). The objects in this study were all preferred and, in fact, equated for degree of preference. Therefore, it is possible that the reason for the lack of differential learning is due to this explanation. At any rate, it is essential that this preliminary study be replicated at least across three phases of PECS instruction.

While several previous PECS studies collected requesting data prior to training in Phase I (i.e., baseline), the current study is unique in that phase-specific baseline data were collected for Phases I–III simultaneously. That is, baseline data for subsequent phases were continuously monitored throughout instruction in all phases. This continuous baseline measure revealed that one student mastered Phase III symbol discrimination while he received instruction in the Phase II distance exchange. This student generalized learning across phases and therefore did not require specific training in symbol discrimination. Since baseline measurement has not been monitored across phases in previous PECS studies, it is unknown whether this generalization may have occurred previously.

In conclusion, PECS instruction during Phases I and II was once again shown to be effective in teaching learners with autism to request objects. As extrapolated from the instructional rationale outlined in the PECS protocol, the iconicity of the symbols used during PECS instruction does not result in differential requesting acquisition during the first two phases. That is, learners do not seem to benefit from symbols with a higher degree of resemblance with their referents. Future research has to determine whether such benefits might emerge during later phases of PECS instruction.

Appendix A. Average iconicity ratings on a seven-point Likert scale

PCS items	Average rating	Bliss items	Average rating
Mirror	6.32	Milk	1.15
Cracker 1	5.66	Donut	1.39
Chip 1	6.58	Top	4.26
Beads	4.72	Cereal bar	1.20
Popcorn 1	6.91	Ribbon	1.32
Ribbon	6.68	Car 1	2.97
Book	6.95	Jack-in-the-box	1.32
Apple juice	6.62	Chip 1	1.15
Slinky	6.61	Yogurt	1.19
Jello	6.16	Ball 1	5.01
Magazine	6.43	Cards	2.04
Popcorn 2	6.91	Cookie	1.24
String	6.84	Juice	1.47
Cracker 2	5.88	Beads	1.15
Ball	6.65	Chip 2	1.16
Chip 2	6.61	Orange juice	1.35
Cracker 3	5.95	Cereal	2.39
Chip 3	6.61	Ball 2	5.19
Rice cake	5.38	Car 2	3.18
Rattle	6.73	Movie	2.09
		Banana	4.73
		Jelly bean	1.18

Note. A rating of 1 indicated very little visual resemblance between a symbol and its object referent, and a rating of 7 indicated a very strong relationship.

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