The Collateral Effects of PECS Training on Speech Development in Children with Autism

Les effets collatéraux de l'enseignement du PECS sur le développement du langage chez les enfants atteints d'autisme

Lynn Carson
Taslim Moosa
Julie Theurer
Janis Oram Cardy

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Lynn Carson, MClSc, S-LP(C),
School of Communication Sciences and Disorders, Western University, London, Ontario, N6G 1H1
Canada

Taslim Moosa, MClSc, S-LP(C),
School of Communication Sciences and Disorders, Western University, London, Ontario, N6G 1H1
Canada

Julie Theurer, Ph.D., S-LP (C),
School of Communication Sciences and Disorders, Western University, London, Ontario, N6G 1H1
Canada

Janis Oram Cardy,Ph.D., S-LP(C),
School of Communication Sciences and Disorders, Western University, London, Ontario, N6G 1H1
Canada

Abstract

Research suggests that 25 to 61% of children with autism will use little or no functional speech to communicate. For these children, many speech-language pathologists will teach the use of the Picture Exchange Communication System (PECS). Studies have reported some children go on to develop functional speech after using PECS. What remains unclear is (i) which children will begin to use functional verbal abilities, and (ii) why this occurs for some and not others. The purposes of this study were to: (a) measure changes in speech production in children with autism after PECS use, and (b) explore whether these changes could be related to children's pre-intervention characteristics, including adaptive functioning, symbolic representation, motor imitation and receptive and expressive language skills. Three male children with autism spectrum disorder aged 2–3 years participated in this study, which followed a single-subject, changing-criterion design. At study outset, speech skills and pre-intervention characteristics were assessed. Parents were then trained to use PECS with their child during weekly clinic and home visits across a five-month period. Speech production data were collected during monthly probes and at post-intervention, then analyzed and compared to pre-intervention characteristics. Results showed changes to speech occurred for Participants 1 and 3. Comparison of pre-intervention characteristics revealed imitation as the only skill area that was different between children, with Participant 3 demonstrating higher motor and verbal imitation scores. These preliminary results suggest that stronger imitation skills may increase the likelihood that a child with autism will develop functional speech after PECS use.

Abrégé

La recherche suggère que de 25 à 61 % des enfants atteints d'autisme utiliseront peu ou pas de langage fonctionnel pour communiquer. De nombreux orthophonistes vont enseigner à ces enfants l'usage du PECS (Picture Exchange Communication System – système de communication par échange d'images). Des études ont rapporté qu'après avoir utilisé le PECS certains enfants continuent à développer un langage fonctionnel. Ce qui reste incertain, c'est (i) de savoir quels enfants commenceront à utiliser des habiletés verbales fonctionnelles et (ii) pourquoi cela se produit-il chez certains et pas chez d'autres. Les buts de cette étude étaient : (a) de mesurer les changements dans la production du langage, chez les enfants atteints d'autisme, après l'utilisation du PECS et (b) d'explorer pour savoir si ces changements pourraient être reliés aux caractéristiques de l'enfant préalables à l'intervention, notamment, le fonctionnement adaptatif, la représentation symbolique, l'imitation motrice et les compétences linguistiques réceptives et expressives. Trois garçons de 2 à 3 ans atteints du trouble du spectre de l'autisme ont participé à cette étude ayant un plan à sujet unique et à critères changeants. Au départ de l'étude, les compétences langagières et les caractéristiques pré-intervention furent évaluées. Les parents furent ensuite formés pour utiliser le PECS avec leur enfant pendant des visites hebdomadaires en clinique et à la maison réparties sur une période de cinq mois. Les données de production de langage furent recueillies à chaque mois et après l'intervention, puis analysées et comparées aux caractéristiques pré-intervention. Les résultats ont montré que des changements s'étaient produits pour les participants 1 et 3. Les comparaisons des caractéristiques pré-intervention ont révélé l'imitation comme étant le seul domaine de compétences qui différait d'un enfant à l'autre, le participant 3 démontrant des pointages plus élevés pour la motricité et l'imitation verbale. Ces résultats préliminaires suggèrent que des compétences plus fortes en imitation peuvent augmenter la probabilité qu'un enfant atteint d'autisme puisse développer un langage fonctionnel après usage du PECS.

Autism spectrum disorder is a developmental disorder characterized by social withdrawal, impairments in communication, resistance to change and repetitive or stereotypic behaviours (American Psychiatric Association, 2000). With respect to communication, research suggests that between 25% and 61% of children with autism will use little or no functional speech to communicate (Weitz, Dexter, & Moore, 1997); a characteristic which can persist into adulthood (Howlin, Goode, Hutton, & Rutter, 2004). When oral communication is present, it is often characterized by delays in speech and language skills relative to chronological age, atypical features such as echolalia or stereotypic speech patterns, and restricted communicative functions (Carr & Felce, 2007).

Several skills have been identified that may influence the development of speech and language abilities in a child with autism. First, Yoder and Stone (2006) suggested that the acquisition of symbolic representation skills are a prerequisite for the development of speech used for communication. Symbolic representation is defined as "the possibility of being able to represent something (object, concept, action, etc.) by means of a differentiated referent serving only for that representation" (Piaget, 1962, in Blanc, Adrien, Roux, & Barthelemy, 2005, p. 231). Therefore, once children acquire this skill, they are able to use and manipulate a symbol (e.g., a word) to represent a specific thing (e.g., an object), regardless of whether it is present or not, to serve a specific communicative function. Blanc and colleagues (2005) have suggested that this ability is disordered in children with autism and may have detrimental effects on speech and language development.

A second possible predictor of later expressive language development is imitation skill. Stone and Yoder (2001) found that motor imitation predicted spoken language abilities in children with autism. The authors suggested that motor imitation includes two skills: (a) attending to another person, and (b) forming a mental representation of that person's behaviour with enough detail to be able to replicate that behaviour. They proposed that these skills underlie the child's ability to learn the social constructs of their community, which includes language. McDuffie, Yoder and Stone (2005) expanded on this study and found that both motor imitation without the use of objects and commenting predicted later language production. Speech imitation skills have also been suggested to predict speech as an outcome of augmentative and alternative communication (AAC) (Yoder & Layton, 1988). Yoder and Layton (1988) found that children with weak verbal imitation skills used fewer words than children with stronger verbal imitation skills after AAC training. The authors suggested that children with low verbal imitation skills fail to process speech in favour of processing the visual information associated with the AAC system and found in the natural environment. Motor imitation impairments are common in children with autism (Williams, Whiten, & Singh, 2004); this may be a potential contributor to the delay in their development of speech and language abilities.

In children with autism, initial language abilities have also been indicated as a predictor for later speech and language abilities. For example, Szatmari, Bryson, Boyle, Streiner, and Duku (2003) suggested that early language skills predicted later communication abilities in children with autism. Smith, Mirenda and Zaidman-Zait (2007) found that expressive language predicted vocabulary growth two years later in children with autism who had varying language abilities at baseline. Consistent with the findings from other studies, the authors also found verbal imitation skills, pretend play with objects and the number of gestures used to initiate joint attention, predicted later vocabulary growth.

For children with autism who do not use speech as their primary mode of communication, many speech-language pathologists will teach the use of AAC strategies to support social communication. This can include the use of pictures, sign language or speech generating devices. One of the most common AAC approaches used with this population is the Picture Exchange Communication System (PECS). Historically, concerns have been raised that using AAC would decrease the amount of natural speech a child will produce (Schlosser, 2003; Bondy & Frost, 1994), which has led to some reluctance in implementing these strategies. Research indicates that, although not a primary goal of PECS, some children have developed speech after using the system (Bondy & Frost, 1994; Charlop-Christy, Carpenter, Le, Leblanc & Kellet, 2002; Ganz & Simpson, 2004; Carr & Felce, 2007; Kravits, Kamps, Kemmerer, & Potucek, 2002; Tincani, 2004; Yoder & Stone, 2006).

A number of hypotheses have been proposed to account for the positive impact of AAC on speech development in children with autism. First, the AAC system may decrease the pressure the child feels to produce speech, and this stress reduction may facilitate speech outcomes (Lloyd & Kangas, 1994). Second, AAC systems may allow the child to avoid the motor and cognitive demands associated with speech production and focus solely on the goal of communication. After establishing a foundation in this area, the child may then be better able to allocate resources necessary for improving speech production (Romski & Sevcik, 1996). Third, behaviourists argue that the principles of

automatic reinforcement encourage speech development based on Skinner's (1957) analysis of verbal behaviour. It has been suggested that the use of an AAC system such as PECS, together with spoken words, paired with a desired item (reinforcement), will not only increase AAC system use, but natural speech production as well (Millar, Light, & Schlosser, 2006).

The development of speech as a by-product of AAC-system use in children with autism is an outcome that has received limited attention in the literature. In an attempt to synthesize the results found to date, Schlosser and Wendt (2008) conducted a systematic review that evaluated the effects of AAC strategies on speech production in individuals with autism. They identified 27 participants across nine single-subject design studies and 98 participants across two group design studies that met criteria for inclusion in their review. Of these studies, they found five single-subject designs that used PECS as the AAC intervention, one single-subject design that compared PECS with sign language, and one group design that compared PECS with Responsive Education and Prelinguistic Milieu Teaching.

The most important finding of Schlosser and Wendt's (2008) review was that none of the studies found a decrease in speech production as a result of AAC intervention. However, the extent of speech gains did vary between studies. The authors suggested that since individuals diagnosed with autism tend to be a very heterogeneous population, these individual differences could, in part, distinguish those children who will develop speech from those who will not.

PECS is a picture-based communication system that teaches children to communicate within a social context (Bondy & Frost, 1994). The protocol is divided into six phases that parallel typical language development. Instruction in each phase uses the basic principles of applied behaviour analysis, such as shaping and differential reinforcement, to teach children to initiate communication. In initial phases, children are taught to request items by giving a picture to a communicative partner in exchange for the item. As stages progress, children learn how to seek out a communication partner, construct multi-picture sentences, and use different communicative functions (Bondy & Frost, 2001).

Since its development, PECS has become one of the more popular AAC strategies used with children with autism for several reasons (Mirenda & Erikson, 2000). First, PECS does not require children to have prerequisite skills such as imitation or attending skills that are necessary for success with most other AAC systems (Bondy & Frost, 1994). Second, PECS begins instruction by teaching children to request, in contrast to most traditional speech and language intervention techniques that first teach children to label. Bondy and Frost (2001) suggest that requesting should be taught first to children with autism since tangible items (e.g., food, toys) can provide more concrete reinforcement. This type of consequence is more motivating to children with autism as compared to social reinforcement (e.g., verbal praise) typically received for labeling (Bondy & Frost, 2001). Third, PECS is a relatively cost-effective and easily portable approach that can be implemented in a variety of settings (Charlop-Christy et al., 2002), making it appealing to both families and professionals.

The acquisition of "useful speech" as an effective mode of communication by age 5-6 years has been identified as one of the best predictors of later adaptive functioning and overall outcome in children with autism (Gillberg & Steffenburg, 1987; Tidmarsh & Volkmar, 2003). This finding is extremely relevant to speech-language pathologists, who focus on improving the communication skills of children in this population. Teaching a child with autism to communicate through speech using traditional methods can be an intensive and lengthy process, with outcomes being variable — and generally unpredictable — for each child (Howlin, 1989; Bondy & Frost, 2001). One example of a traditional approach is the use of operant methods to teach children to speak using imitative responses of words or word approximations. Another is using a clinician-directed approach to establish verbal responses during elicitation tasks such as labelling. The assumptions of both these approaches is that children with autism have the basic prerequisite skills to engage in this form of learning (e.g., sitting and attending skills), the prompts used for teaching can be easily faded out to allow for spontaneous use of language, and learning verbal skills in one context will generalize to other environments or people; none of which may be true for certain learners (Bondy & Frost, 2001). Therefore, there is a tremendous need in the field of speech-language pathology to understand how to best capitalize on gains in spoken language acquisition that may be made with AAC.

The present pilot study had two main purposes. The first purpose was to measure changes in the speech of children with autism using PECS following a parent-training model. Specifically, we examined pre and post intervention changes to speech sounds (e.g., 'ah', 'oo', etc.) and words (e.g., proper nouns and words found in the dictionary) used by children during requests. PECS was used because it is one of the more common AAC approaches chosen for implementation in clinical practice with children with autism. A parent-training model was selected because it has been demonstrated to

be an effective intervention approach for children with autism (Brookman-Frazee, Vismara, Drahota, Stahmer, & Openden, 2009; McConachie & Diggle, 2007) and early language delays (Roberts & Kaiser, 2011). It was also selected for reasons of ecological validity, described in further detail below. Studies have indicated that interventions that include opportunities for parents to practice their new skills with their child during the training session, and that include feedback in the practice session are more effective than parent-training interventions without these elements (Kaminski, Valle, Filene, & Boyle, 2008; Ingersoll & Dvortcsak, 2006; Kaiser & Hancock, 2003; Kaminski et al., 2008). As a result, our parent-training model included practice-with-feedback.

The second purpose was to determine if any changes in speech were related to the children's pre-intervention characteristics. Few studies have compared children's pre-intervention characteristics prior to AAC intervention to determine what skills a child possesses before training that may encourage speech development. Therefore, in this study, extensive pre-intervention assessment was conducted of each child's language, symbolic representation, imitation and adaptive functioning.

A supplementary purpose of this study aimed to establish an ecologically valid and reliable design that could be used on a larger scale in future research. We sought to establish ecological validity by implementing PECS in a manner consistent with clinical services offered to families of children with autism in the community in which the study was conducted. Children with autism residing in the study region who receive PECS instruction in the context of speech and language services, tend to receive 30 to 60 minutes of therapy per week. Additional in-home support services for PECS are also available to families through Applied Behaviour Analysis (ABA) programs and children's treatment centers. In our study, parents received PECS training in clinic once per week for thirty minutes, similar to what may occur during one type of direct speech and language therapy. Families were then asked to continue using PECS at home with their child, and consultation was also provided once per week in the home environment. This type of scenario is similar to what may be offered by in-home ABA support services.

Method

Participants

Three male children with autism spectrum disorder participated in the study. All participants (a) had a diagnosis of autism spectrum disorder made by a child psychiatrist, developmental paediatrician or multidisciplinary team; (b) came from a home in which the primary language spoken was English; (c) had normal hearing according to audiological assessment; (d) had not been taught to use an AAC system prior to the study; and (e) were considered to have no functional verbal language, defined by fewer than 20 different words used communicatively (Yoder & Stone, 2006). Although not a requirement to participate, none of the children were enrolled in any other therapies for the duration of the study. The *Pragmatics Profile of Everyday Communication Skills in Pre-School Children – Revised (PPECS-R)* was used to obtain information from parents regarding their children's communication skills prior to intervention.

Participant 1 was aged 3 years, 5 months at study outset. His parents reported that he did not use any spontaneous speech but relied on gestures to communicate, which was consistent with researcher observations. They also reported that he initiated communication infrequently, and when he did, requests for food or access to favourite toys were the primary messages. When requests were denied or delayed, he sometimes exhibited maladaptive behaviour. Observations of Participant 1 prior to intervention also revealed minimal joint attention abilities, delayed play skills and a restricted range of interests. Participant 1's mother was 31-years old, of Korean ethnicity, with a university education.

Participant 2 was 3 years, 5 months at study outset. His mother reported that he did not use spontaneous speech and rarely initiated communication. She also reported that when he did initiate communication, he used gestures. Communication mainly surrounded requests for desired objects; however, in general, he persistently attempted to access items independently, including moving or climbing on furniture. Occasionally, Participant 2 would also request to engage in social games he played with his mother. These reports were consistent with what was observed prior to intervention. In addition, Participant 2 exhibited poor joint attention abilities and a tendency to easily lose interest in objects and activities. Participant 2's mother was 40-years old, of South African origin, and had a college education.

Participant 3 was aged 2 years, 4 months at study outset. His mother reported that he did not use spontaneous speech to communicate and he rarely initiated communication. She indicated that his preference was to use gestures to request desired objects or food; however, on other occasions he would look at a desired object and cry. His mother reported his preference was to play on his own, typically walking away when others attempted to engage with him. She also reported that he had a very limited number

of preferred toys or food items. The information obtained from the parental report was consistent with observations of Participant 3 in the clinic. In addition, he displayed severely delayed joint attention and play skills. Participant 3's mother was 37-years old, Caucasian and had completed high school.

Setting

Assessment and PECS Training Sessions. Assessment and PECS training were conducted in the H. A. Leeper Speech and Hearing Clinic at Western University. During the pre-intervention assessment, several preferred items were placed around the room. During PECS training, a subset of preferred items would be placed in the room at the beginning of clinic visits. Some would remain out of reach until training began and others were available for the child to play with while the child's mother discussed the progress made since the last visit, and goals for the current session, with the researcher. This process lasted approximately one to five minutes. Assessment and PECS training sessions were videotaped by a member of the research team who was present in the room.

Home visits. During home visits, children used PECS in various rooms of the house (e.g., living room, kitchen, dining room). In general, home visits only included the child, the mother and the researcher; however, on occasion, the child's father or sibling would be present and at times participated. Participant 1 also had two visits conducted at the daycare setting he attended during the final month of PECS training. The research team provided consultation to the daycare staff regarding ways to implement his PECS skills into their program (e.g., snack time, circle time).

Materials

Preferred Items. Preferred items were chosen based on observed preferences during assessment, parental input and ongoing preference assessments throughout the study. Preferred items included toys, books, food and activities that each child found reinforcing. Examples of toys include cars, balls, tops, musical toys, bubbles and electronic toys. Examples of books include magazines, auditory books and picture books. Activity examples include colouring, painting, tickles, videos and social games. Food items were only used with Participant 1 and included fruit snacks, Smarties and fish crackers.

PECS Materials. All picture icons were created using the *Pics for PECS* software provided with the PECS training manual. For pictures of preferred items that were not available via this software, identical images of the items available from the Internet were used. All picture icons were in colour and a small piece of Velcro was attached to the back. For Participant 1 and 3, the picture icons were 1.75" X 1.75" throughout the entire study. For Participant 2, during initial training, picture icons were enlarged to 4" x 4". However, as the training progressed his picture icons were systematically decreased in size to 2" x 2".

At the appropriate time in the training, children were provided with a three-ring binder (15cm x 23cm) to use as their communication book. The binders had several thin strips of Velcro attached to both the outside and inside, on which picture icons could be adhered. At the bottom edge of the binder, there was a longer additional piece of plastic known as the sentence strip, which was used in later phases of PECS training. This had Velcro on one side to adhere it to the communication book, and Velcro on the other side for adhering the picture icons. An example of picture icons used is provided in Figure 1.

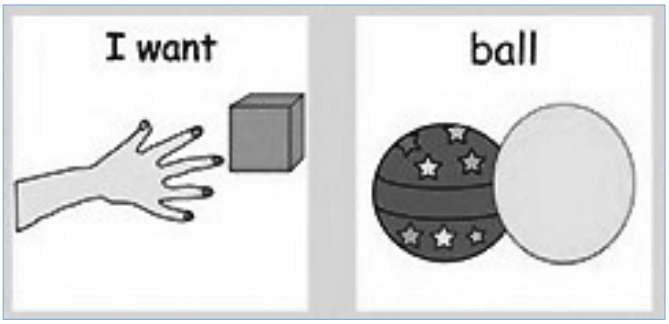

Figure 1: An example of picture icons used by children as would be seen on the sentence strip.

Procedure

A single-subject, changing criterion design was used to evaluate the collateral effects of PECS training on speech development. A set of three language samples was conducted prior to and following PECS training to establish a representative sample of speech skills before and after intervention. To determine change across these samples, each child's speech/oral communication was assessed relative to the following dependent variables: (a) frequency of use of sounds to communicate across communicative intents; (b) frequency of use of words to communicate across communicative intents; (c) percentage of adaptive communication, either verbal or nonverbal; and (d) percentage of maladaptive communication, either verbal or nonverbal. Sounds were defined as any phoneme used in the English language (e.g., /p/, /i/) or phoneme combinations (e.g., /ba/, /badigu/) not separated by pauses that cannot be categorized as words. Words were defined as any language form found in the Webster's English Dictionary or proper nouns (e.g., Dora, Mickey). Adaptive communication was defined as any behaviour used to send a message to the listener (e.g., verbal, non-verbal or

both combined) that would be considered appropriate by most adults, for example, pointing to an item to make a request, turning a head away from an object to indicate protest/refusal or taking an adult's hand to gain attention. Maladaptive communication was defined as any behaviour used to send a message to the listener (e.g., verbal, non-verbal or both combined) that would be considered inappropriate by most adults, for example, tantrum behaviour such as screaming and crying to request an item, hitting a person to indicate protest/refusal, or biting the listener's arm to gain attention.

Language probes were also conducted once per month to measure changes in speech throughout the intervention.

Pre-Intervention Assessment

Language. Three, 20-minute language samples were collected approximately one week apart to provide baseline information about the children's speech skills in context. Researchers created a play setting in the clinic room by making preferred toys available for the child to access. Researchers then interacted with the child and created communicative temptation scenarios to provide an opportunity for the child to communicate (e.g., provide bubbles with the lid on, place desired item slightly out of reach, etc.).

Standardized assessment of language was conducted using the *Preschool-Language Scale – Fourth Edition* (*PLS-4;* Zimmerman, Steiner & Pond, 2002). The *PLS-4* was chosen to provide a measure for receptive and expressive language that ranges from birth onward, therefore having the capability of capturing early developing language skills. With this tool, we were able to obtain a standard score for language ability using caregiver report, observation or elicitation tasks.

Adaptive Functioning and Socialization. The Parent/Caregiver Rating Form for the *Vineland Adaptive Behaviour Scale – Second Edition (VABS-2*; Sparrow, Cicchetti & Balla, 2005) was used to measure the children's level of overall adaptive functioning in their environment. The Socialization subdomain was also used to evaluate the children's social interaction skills.

Imitation. Two types of imitation skills were assessed: a) motor imitation (with and without objects) and b) verbal imitation. Motor imitation was assessed using the Visual-Motor Imitation subtest of the *Psychoeducational Profile – Third Edition (PEP-3*; Schopler, Reichler, Bashford, Lansing, & Marcus, 1990.). Verbal imitation skills were assessed using the *Early Echoic Skills Assessment (EESA*; Esch, 2008). This informal tool assessed the child's ability to imitate early developing vowel and consonant sounds at the syllable and word level.

Symbolic Representation. Parents completed the *Communication and Symbolic Behaviour Scale-Developmental Profile (CSBS DP) - Infant and Toddler Checklist* (Wetherby & Prizant, 2002). The Symbolic Composite was used to measure symbolic representation skills in each child.

PECS Training

PECS training sessions were implemented by three, second-year graduate students in speech-language pathology at Western University. One student, the first author, acted as the primary researcher for this study and had additional training in the field of ABA, with six years' experience implementing PECS with children with autism. Each member of the research team had attended a PECS basic two-day training workshop offered by Pyramid Consultants before the study began. Prior to study outset, the primary researcher also provided training to the other two graduate students regarding basic principles of ABA. In addition, she provided regular feedback regarding each child's progress throughout the study.

In general, one member of the research team was assigned to work with a particular child for the duration of the study. However due to scheduling conflicts, occasionally another member of the research team would conduct the PECS training sessions. The mothers of all three children received training with their child in clinic, and were also primarily involved in home visit consultations.

Clinic visits occurred once per week, during which time the mothers were taught how to implement PECS with their child following the protocol outlined in the PECS training manual (Frost & Bondy, 2002). All children began at Phase 1 and, upon mastery, moved forward through each phase in sequence. A description of each phase is provided in Table 1. Mastery criterion was 80% correct independent trials (at least 10 trials per session) for three consecutive sessions, with at least two communication partners, in two different settings, with at least five items. Specific target behaviours for mastery and error correction procedures were unique to each phase and outlined *a priori* based on recommendations from the training manual.

The clinic sessions were 30-40 minutes in length. During the first five minutes of the clinic visit, the child's progress since the last visit and goals for the current session were discussed. During this time, the child was allowed to access a few preferred items. Then, PECS training occurred for approximately 30 minutes,

Table 1. Outline of PECS Phases Based on Recommendations from the PECS Training Manual – Second Edition (Frost & Bondy, 2002).

PECS Phase	Description
Phase 1 – "How" to Communicate	Children are taught to approach a communication partner and exchange a picture, at which point they receive a desired item
Phase 2 – Distance and Persistence	Children are taught to travel to their PECS binder and their communication partner at increasing distances. They are also taught to be persistent communicators regardless of what the communication partner is doing
Phase 3a – Picture Discrimination	Children learn to discriminate between pictures of preferred items and non-preferred, neutral and low-preferred items
Phase 3b – Picture Discrimination	Children learn to discriminate between pictures of highly preferred items
Phase 4 – Sentence Structure	Children are taught to build multi-picture sentences by placing an 'I want' picture icon and a preferred item picture icon on the sentence strip. They then exchange the sentence strip with the communication partner
Phase 5 – Responsive Requesting	Children learn to respond to the question "what do you want?" by going to their communication book and requesting a desired item
Phase 6 – Commenting	Children are taught to respond to various questions (e.g., "what do you see?", "what do you hear?"). Then they are taught to spontaneously comment using these sentence starters (e.g., "I see...", "I hear...")

with the researchers providing modeling and verbal feedback to train parents to implement PECS with their child. After PECS training, approximately five minutes was spent debriefing the parent regarding the current session, along with answering any more detailed parent questions. Parents were encouraged to implement the strategies learned in clinic at home with their child; however, no specific amount of time was recommended or required.

Home visits were also conducted once per week for approximately 30 minutes. During this time, researchers observed mothers using PECS with their child in the home environment. Feedback was given by the researchers regarding the parent's use of the strategies discussed in clinic sessions and the child's progress toward their current PECS goal. As well, specific parental questions were answered at this time. The home visits were designed to ensure generalization of PECS skills to an environment in which the child will most likely use PECS post-intervention. Also, these home visits were designed to provide support to parents experiencing challenges with the implementation of PECS specific to the home environment.

PECS training continued consistently for a five-month period with a two-week break for Christmas holidays when the H. A. Leeper Speech and Hearing Clinic was closed.

Probes. One PECS training session for each child was randomly selected per month to assess how speech was developing throughout the study. To maintain observational duration that was consistent with the language samples, the primary researcher watched only the first 20 minutes of the video recorded clinic session.

Post-Intervention Assessment

Language. Three, 20 minute language samples were collected post-intervention to ensure a representative sample of speech skills was captured. Researchers established similar conditions as described in the pre-intervention language samples such as setting up a play setting in the clinic room and creating communication temptation scenarios. A few of the preferred items available were different in the pre- versus post-intervention language samples. This difference was due to the fact that children had developed new preferences for certain items throughout the study. A second difference was that each child's PECS binder was available for use during the post-intervention samples.

Parent Questionnaire. A final parent questionnaire was given to collect information regarding maternal characteristics, frequency and duration of PECS use away from clinic and changes to behaviour and communication that the parents noted at home.

Analysis

At the outset of the study, planned dependent variables included frequency of sounds and words used to across communicative intents, and percentage of both adaptive and maladaptive communication. As the study progressed, it was noted that all three children's communicative functions were mainly restricted to requesting and protesting. Protest behaviour was rare and mainly restricted to non-verbal behaviour. In general, all three children chose to ignore the communication partner instead of engaging in maladaptive communication. During language samples, more consistent attempts were made to contrive protest behaviour to observe communicative responses. Following several attempts to elicit this type of communicative intent, children would use non-verbal protest behaviour to communicate with the researcher (e.g., turning a head, pushing object away). These types of communication exchanges were not contrived during the intervention process and protest behaviour rarely occurred spontaneously during this time. In contrast, the majority of non-verbal and verbal behaviour for all children occurred during requests, in both the gathered language samples and intervention sessions.

As a group, the children also did not exhibit any maladaptive behaviour to communicate during the pre and post assessment or intervention phases of the study. Typically, they would oscillate between engaging with the researcher or parent to make requests and disengaging all together. For example, children would walk around the room, sit on the floor or begin other self-stimulatory behaviours (e.g., playing with their fingers, pulling their clothing or rubbing the floor).

As a result of these observations, only the frequency of sounds used to request and the frequency of words used to request were analyzed. Requests were defined as the child independently approaching the adult and/or using sounds or words with the intent to send a message to a communication partner to access a desired item/activity (e.g., object or action). The vocalizations may or may not have been accompanied by a nonverbal behaviour (e.g., pulling adult's hand toward an item and saying /ah/, giving an item and saying /open/, exchanging a picture icon and saying /i-i-i-i/). Data were collected on dependent measures from video recordings of pre- and post-intervention language samples and from monthly probes of video recorded PECS training sessions.

Interobserver Agreement. Interobserver agreement (IOA) was calculated to determine the reliability of the observations by using a point-by-point agreement ratio. An agreement occurred when both observers independently recorded the same observation. Reliability was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplied by 100.

The primary researcher and an unfamiliar observer independently coded observations. The unfamiliar observer was a second-year graduate student in Speech-Language Pathology at Western University who was not familiar with the children and was blind to the study purpose. Informal training of coding procedures was conducted prior to the unfamiliar observer watching the videos. Reliability was based on IOA data from language samples pre- and post-intervention.

With respect to the frequency of sounds used to request, the average IOA for Participant 1 was 99%, for Participant 2 was 71%, and for Participant 3 was 63%. With respect to the frequency of words used to request, Participant 3 was the only child for whom this calculation was relevant, and the average IOA was 100%.

It appeared that the difficulty in establishing higher reliability for some participants was mainly a result of disagreement regarding the communicative intent of the behaviour. The unfamiliar observer had a greater tendency to code behaviours as communicative compared to the primary researcher. Since the opportunity for both coders to reach consensus was not available, only those behaviours that both coders agreed upon in independent analyses were retained for analysis.

Results

Pre-Intervention Characteristics

Data for each child are summarized in Table 2 for all areas assessed.

Symbolic representation. Standard scores could not be calculated since participants were chronologically older than the maximum age established for the *CSBS DP - Infant and Toddler Checklist* norms. Therefore, symbolic representation skills were compared based on each child's raw scores from the Symbolic Composite. The participant's raw scores ranged from 9 to 13. Analysis of individual items revealed Participant 1 consistently looked when his name was called, understood 11-30 words or phrases without the use of gestures, played with a variety of objects, and used a few familiar items for their intended use (e.g., cup, bowl, spoon, toothbrush). He did not exhibit any pretend play. Participant 2 had a similar profile, however attending to his name was inconsistent; he understood 4-10 different words or phrases without gestures and engaged in some pretend play. Participant 3's individual item responses were identical to Participant 1's except his parents

Table 2. Individual Performances on Measures of Symbolic Representation, Imitation, Language, and Adaptive Functioning Administered Pre-Intervention.

PECS Phase	Participant 1	Participant 2	Participant 3
CSBS:DP Symbolic Representation raw score	11	13	9
PEP-3 Visual Motor Imitation percentile rank	13th	22nd	44th
EESA Verbal Imitation raw score	0	0	5.5
PLS-4 Auditory Comprehension standard score (95% CI)	50 (50-57)	50 (50-57)	61 (54-68)
PLS-4 Expressive Communication standard score (95% CI)	61 (54-68)	61 (54-68)	68 (61-75)
VABS-2 Socialization standard score (95% CI)	61 (54-68)	63 (56-70)	65 (58-72)
VABS-2 Adaptive Behaviour standard score (95% CI)	52 (47-57)	61 (56-66)	65 (61-69)

Note. CSBS:DP = Communication and Symbolic Behavior Scales: Developmental Profile Infant/Toddler checklist; PEP-3 = Psychoeducational Profile, 3rd edition; EESA = Early Echoic Skills Assessment; PLS-4 = Preschool Language Scale, 4th edition; VABS-2 = Vineland Adaptive Behavior Scale Parent/Caregiver Rating form, 2nd edition

reported variability in attending to his name and occasional interest in different objects for play.

Imitation. Children's imitation skills were compared based on values obtained using the *PEP-3* and *EESA*. Each child received a percentile score for the Visual Motor Imitation subtest on the *PEP-3*. Participant 1 received a below average score, while Participant 2's motor imitation was estimated to fall in the low average range. Participant 3 received a score that placed his motor imitation skills in the average range. Participant 3 also received the highest score for verbal imitation as assessed by the *EESA*. He received a raw score of 5.5 out of 25 for Group 1 targets, which included imitating syllables ah, oo, oh, wa wa, moo and baa. This is in contrast to Participants 1 and 2, who demonstrated no verbal imitation skills for any targets.

Language. All three participants performed significantly below average on both the Auditory Comprehension and Expressive Communication subtests of the *PLS-4*. Receptive language skills were at the 1st percentile for all participants. Expressive language skills were at the 1st percentile for Participants 1 and 2, and at the 2nd percentile for Participant 3.

Adaptive functioning. Standard scores from the Socialization Subdomain and the Adaptive Behaviour Composite from the *VABS – 2* Parent/Caregiver Form were well below average for all participants. Parent reports placed socialization skills at the 0.5th percentile for Participant 1 and at the 1st percentile for Participants 2 and 3. Adaptive behaviour functioning was below the 1st percentile for Participants 1 and 2 and in the 1st percentile for Participant 3.

Acquisition of PECS

Participant 1 met criterion for Phases 1, 2, 3a, 3b and 4. He was simultaneously learning Phase 5 and the attributes *big* and *little* at the time of reassessment. His mother reported they practiced PECS at home five days per week, for approximately 4 to 6 hours per week.

Participant 2 met criterion for Phases 1, 2 and 3a. He was progressing through Phase 3b when reassessment began. His mother reported they practiced PECS away from clinic six days per week, for an approximate total of 10 to 12 hours per week.

Participant 3 met criterion for Phase 1 and Phase 2. He was learning Phase 3a at the time of reassessment.

His mother reported they practiced PECS at home five days per week, totalling approximately 4 to 6 hours of training per week away from clinic.

Speech Requests

At baseline, the frequency with which Participant 1 used sounds to request ranged from 2 to 8 in the 20-minute sample. During PECS training, he began to show slight increases in this behaviour. At post-intervention, he continued to increase the frequency with which he used sounds to request, ranging from 8 to 18. Participant 1 was not observed to use any words to request at baseline, throughout training or post-intervention.

At baseline, the frequency with which Participant 2 used sounds to request ranged from 0 to 5. During PECS training, his use of sounds to request remained at baseline levels; however, at post-intervention, there was a slight increase in the frequency with which he used sounds to request, ranging from 1 to 12. Participant 2 was not observed to use any words to request at baseline, throughout training or post-intervention.

Throughout baseline, Participant 3's frequency of requests using sounds ranged from 2 to 18. Once PECS intervention began, the frequency with which he used sounds to request decreased steadily to zero and remained at zero throughout Phase 1. Upon introduction of Phase 2, Participant 3 began to increase the frequency with which he used sounds to request, ranging from 0 to 4 post-intervention. At baseline, he did not use any words to initiate requests. During the intervention, he used the word *bye-bye* paired with the exchange of a picture icon, to request to play by himself. Post-intervention, Participant 3 initiated requests using the word *open*, accompanied by giving a closed container or bag to the adult, on four occasions.

All children accompanied sound use with a nonverbal behaviour to initiate requests. As well, Participant 3 consistently used nonverbal behaviour to support all word use. Data for each child are shown in Figure 2.

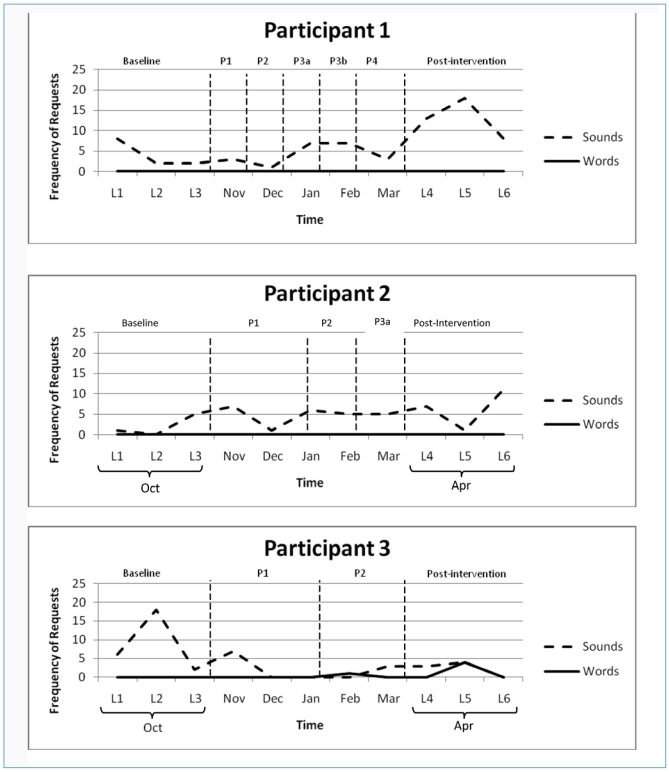

Figure 2: Frequency of requests made with sounds and words during baseline, PECS training and post-intervention for each participant. P1, P2, P3a, P3b and P4 reflect PECS stages.

Discussion

In this pilot study, three children with autism were taught to use PECS using a parent-training model. Mothers were trained to implement PECS with their child in a clinical context and then generalized their child's PECS skills in the home environment. A single-subject, changing criterion design was used to measure collateral changes in speech that occurred during PECS training. Several studies have shown improvements in speech after children with autism have used the PECS system (Bondy & Frost, 1994; Charlop-Christy et al., 2002; Ganz & Simpson, 2004; Carr & Felce, 2007; Kravits et al., 2002; Tincani, 2004; Yoder & Stone, 2006). To our knowledge, this is the first attempt to include extensive assessment of children's pre-intervention characteristics across multiple domains in an effort to identify features that distinguish those children who develop functional speech after PECS use from those who do not. The results of this study suggest that children with stronger imitation skills pre-intervention may be more likely to develop speech after PECS intervention.

The first goal of the study was to measure changes to speech in children with autism following PECS intervention. All three children showed unique data patterns between pre and post intervention. Participant 1 showed an increasing trend from baseline to post-intervention in his use of sounds to request. He did not use words to request throughout the duration of the study. Data for Participant 2 showed relatively no change to his use of sounds during requests throughout the study. He also did not use any words at the study outset, throughout the duration of the study, or at post-intervention. Finally, Participant 3 was using more sounds to make requests at baseline compared to the other two children. Once PECS intervention began, his use of sounds to request declined to zero; however, during Phase 2, this behaviour began

to increase. More interestingly, data showed that Participant 3 was the only child to start using words to request through the intervention period and at post-intervention. Anecdotally, it is also relevant to note that Participant 3 was also using words in other contexts throughout the study that were not captured during the language assessments or during video recordings of PECS training. During the beginning of Phase 1 training, Participant 3 would spontaneously say "bye-bye" to the researcher when leaving the clinic. He also spontaneously imitated words during PECS training, such as "yay" and "thank you" and displayed delayed echolalia for words he had previously heard, such as "wow" and "smile for me."

The second goal of the study was to determine if changes to each child's speech could be related to their individual pre-intervention characteristics. Evaluation of pre-intervention characteristics failed to reveal skill differences among the children with respect to socialization and receptive and expressive language; confidence intervals from the *VABS – 2* Socialization subdomain and *PLS – 4* standard scores overlapped. With respect to overall adaptive functioning as measured by the *VABS – 2*, Participant 3 was slightly stronger than Participant 1 given the non-overlapping confidence bands. There were also minimal differences between children's symbolic representation skills when comparing scores received on the *CSBS DP – Infant and Toddler Checklist*, with Participant 3 having slightly poorer symbolic representation skills than the other two boys. Since these results indicated that the children had similar skills at pre-intervention with respect to language, socialization, adaptive functioning and symbolic representation, it suggested that these skill domains may not be related to changes in their speech.

The most relevant finding with regards to pre-intervention characteristics was that Participant 3 had notably better imitation skills than the other two participants as measured by the *EESA* and the *PEP-3*. Not only did he have stronger motor imitation skills (with and without objects), but he was the only child who demonstrated verbal imitation skills at study outset. Since Participant 3 was the only child to begin to use words to request, this result could suggest that stronger imitation skills may increase the likelihood of functional speech developing after PECS intervention. This finding is consistent with suggestions from Charlop-Christy et al. (2002) that imitation skills may facilitate changes to verbal behaviour, and with results from Schwartz, Garfinkle and Bauer (1998) that children who could imitate during and following PECS intervention made greater improvements in speech production compared to those who could not.

Further interpretation of these results requires the consideration of findings from previous research for a more accurate analysis. First, Participant 1's data showed an increase in sounds used to request throughout PECS intervention; however, these data should be interpreted with caution. Although Participant 1 did show an increase in sounds used to request, he did not use any words. As well, the sounds Participant 1 used were a random assortment of phonemes that were always accompanied by nonverbal behaviour (e.g., exchanging a picture and saying "aidagadu") but also frequently occurred when he was on his own, away from a communicative context. Previous research from Ganz and Simpson (2004) suggested that changes to non-word vocalizations were not related to changes in word use after children used PECS. Therefore, although Participant 1 began using more sounds during requests, this may not be indicative of the development of functional speech.

Inspection of Participant 3's data might be initially interpreted as support for the hypothesis that children's speech will decline with AAC intervention, but this initial assumption could be misleading. Bondy and Frost (1994) pointed out that some children who do develop speech after PECS use, will, at some point, display a period where picture use is their only effective communication method. Research also suggests that significant increases in word use may not be seen until Phase 3 or 4 in PECS, or perhaps ever later (Ganz & Simpson, 2004; Kravits et al., 2002; Bondy & Frost, 1994). Since Participant 3 was just starting Phase 3, it is possible that the higher frequency of verbal behaviour to make requests is just the beginning of an increasing trend.

One limitation of this study was that the design did not account for maturation. Therefore, it is possible that the changes in speech would have occurred regardless of PECS intervention. A second limitation was the limited time within which PECS intervention occurred. The short study duration makes it difficult to observe any large or long-term changes to sound and word use. Also, research suggests that increases to word use are mainly seen in later stages of PECS, therefore the trends in the data may have appeared different for each child if progress was tracked for a longer period. Third, assessment tools used to measure pre-intervention characteristics may not have captured the entire extent of each child's specific skill level in that area. For example, although the *PLS-4* provided a standardized method of testing and comparing scores, a more informal method may have captured more specific language differences. Also, the *Communicative and Symbolic Behaviour Scale* offers a more in depth

assessment of prelinguistic skills, including symbolic representation, compared to the *CSBS DP – Infant and Toddler Checklist*. This standardized tool would have also yielded percentile ranks and standard scores for a more accurate comparison of skill level. A fourth limitation is that this study included only three children. It is possible that additional participants would have revealed different patterns in pre-intervention skill level and speech outcomes, therefore influencing the overall interpretation of the results. Finally, fidelity measures were not taken during intervention, therefore, it is possible that the method of intervention delivery was not consistent across participants and may have had an effect on the outcomes seen. Although this is a consideration, it is important to remember that the way the intervention was provided in this study is reflective of how intervention is delivered in the community and is therefore in keeping with the goal of ecological validity.

Although it is rare for speech-language pathologists to offer home training services similar to what occurred in this study, it is not uncommon for children with autism to have access to this type of support through other means offered concurrently with speech and language treatment. This could include home training provided by ABA programs, as well as access to workshops and training offered by community children's treatment centers. Based on this, we felt the intervention model used in this study realistically captures what can happen in the community to support these families, therefore achieving the goal of ecological validity for this study design. Future research could consider eliminating the home visits but providing details regarding other community support resources families received during the intervention. The challenge with this model would be the likelihood that the children would not receive the same kind of support from the community, therefore adding a confounding variable to the interpretation of the final results. Although this confounding variable would be a factor to consider, research that lists the services families accessed outside of the clinical context may be more practical for most speech-language pathologists to conduct within their practice, rather than providing those services themselves.

Another point to consider regarding the home visits in this study relates to the amount of time parents implemented PECS in the home. Based on post-intervention parent report, mothers stated they used PECS with their child approximately 1-2 hours per day. It is unclear whether this frequency of PECS use at home would have occurred in the absence of the home visits, which may have acted as an incentive for regular use. Future research could examine the level of impact home support has on parent performance with regards to PECS use in the home.

Future research should include larger sample sizes and a study design that accounts for maturation. The effects of a longer period of intervention should also be examined, namely, a duration that allows children the opportunity to master all PECS phases. This increased period of observation would also provide greater opportunity to study long-term changes in speech, as well as other communicative functions. In addition, examination of changes to non-verbal communicative behaviour would also be valuable. Our clinical observations were that all three children initiated communication more often using PECS. Future research could more objectively compare how often children use speech to communicate in the context of their overall communicative rate including PECS. Also, measuring changes to other prelinguistic skills would be informative to clinical practice. Following this study, all parents reported their children showed increases in intentional communication at home, comprehension of language, eye contact and imitation skills. This type of evidence would be valuable to clinicians making treatment recommendations to families of children from this population. Finally, it would be useful to include assessment of other skills such as joint attention and play skills that research has suggested are also related to later expressive language growth in children with autism.

Overall, results from this study suggest that stronger imitation skills may encourage speech development as a collateral effect of PECS training. Given the preliminary nature of this study, this finding should be interpreted with caution. This pilot study was able to provide an ecologically valid framework upon which future research can build to examine why some children with autism develop speech after PECS use. This contribution is especially valuable to the clinical literature in speech-language pathology where there is great need for ecologically valid research that will enable clinicians to provide families with more information about potential treatment outcomes. Continued research in this area is critical, not only for speech-language pathologists, but for other professionals who implement PECS with children with autism. If research can confirm what type of speech improvements occur with PECS, and with whom they are most likely, we can capitalize on a simple intervention procedure that could significantly alter outcomes in the lives of children with autism.

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Authors' Note

Correspondence concerning this article should be addressed to: Lynn Carson, Child Development Centre of Oakville, 410 North Service Road East, Unit 1, Oakville, ON, Canada. L6H 5R2. Email: lynn.carson@cdco.com or l_dales@hotmail.com

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