Teaching Children with Autism to Initiate and Respond to Peer Mands Using Picture Exchange Communication System (PECS)

Amanda Doherty¹ · Maeve Bracken² · Laura Gormley^{1,2,3}

Published online: 30 October 2018
© Association for Behavior Analysis International 2018

Abstract

We evaluated the effects of systematic prompting plus reinforcement on listeners' independent responses to peer mands and on speakers' peer-directed mands using the picture exchange communication system (PECS) in two studies. In Study 1, three PECS users with a diagnosis of autism were trained to direct PECS exchanges toward peers, whereas in Study 2, three peers with autism were taught to accept a PECS card, select the requested item from an array of three items, and place it in front of their peer. Study 1 showed an increase in peer PECS mands that generalized to novel trained peers for all participants. Results of Study 2 demonstrated an increase in correct independent responses to PECS exchange for all participants, a response that readily generalized across peers and settings for two out of three participants. These results suggest that this intervention protocol may be an effective way to increase interactions between peers with autism.

Keywords Autism · Picture exchange communication system · Peer listener responding · Generalization

Children with autism spectrum disorder (ASD) frequently exhibit major deficits in reciprocal social interaction, which often hinders both their response to the initiations of others and the social initiations themselves (Koegel, Park, & Koegel,

2014). Research has shown that in the absence of intervention, typically developing children have favored social interactions with other typically developing peers (DiSalvo & Oswald, 2002). Gonzalez-Lopez and Kamps (1997) have also noted that children with ASD can frequently leave a situation to avoid social contact or even exhibit negative responses, making it difficult for typically developing peers to initiate and maintain interactions with them. Therefore, it is vital to target the initiation, responding, and maintenance of peer interactions in children with ASD in order to overcome the lack of relatedness that children with ASD often experience while also increasing the reinforcement experienced by their peers (Belchic & Harris, 1994).

A specific form of peer interaction that has been targeted within behavioral research is the mand, “a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation” (Skinner, 1957, pp. 35–36). Hancock and Kaiser (1996), for example, successfully taught children with ASD to vocally mand with their typically developing siblings through sibling-delivered prompts. Taylor et al. (2005) taught children to vocally mand with their peers by creating an establishing operation (EO) and systematically prompting the required response. According to Michael (1993), an EO is an “environmental event, operation, or stimulus condition that

Research Highlights

- Children with autism can learn to direct PECS mands toward their peers.
- Prompting and reinforcement can be used to teach children with autism to respond correctly to peer PECS mands for a variety of stimuli.
- Responses to peer PECS mands indicated generalization across both peers and settings and maintenance at follow-up for the majority of participants.

✉ Maeve Bracken
mbracken@tcd.ie

Amanda Doherty
dohertal@tcd.ie

Laura Gormley
gormleyl@tcd.ie

¹ Play and Language Support (PALS) preschool, Unit 18, Northwest Business Park, Blanchardstown, Dublin 15, Ireland

² School of Psychology, Aras an Phiarsaigh, College Green, Trinity College Dublin, Dublin 2, Ireland

³ Economic and Social Research Institute, Dublin, Ireland

affects an organism by momentarily altering (a) the reinforcing effectiveness of other events and (b) the frequency of occurrence of that part of the organism's repertoire relevant to those events as consequences" (p. 192). In the case of Taylor et al. (2005), they created an EO by limiting participants' access to food prior to the study. Despite the presence of an EO, participants only requested preferred items from adults; they did not direct their requests toward peers in the absence of systematic teaching. This lack of generalization to peers has also been demonstrated in later research (Pellecchia & Hineline, 2007).

More recently, Paden, Kodak, Fisher, Gawley-Bullington, and Bouxsein (2012) investigated peer manding between children with ASD who used the picture exchange communication system (PECS), an augmentative and alternative communication (AAC) system commonly used with children with ASD (Bondy & Frost, 2001). Through systematic prompting and the extinction of adult-directed mands, the two study participants were successfully taught to independently request a range of items from a peer using PECS during tabletop sessions. Furthermore, a significant portion of these trials also resulted in additional social interaction. A later study by Kodak, Paden, and Dickes (2012) replicated and extended the findings of Paden et al. (2012) when they assessed the generalization of PECS mands to a novel peer and a more natural setting. Kodak et al. (2012) successfully taught participants to approach peers from distances of 3.5 m and 7 m and to mand using PECS, which simulated a typical classroom environment and demonstrated generalization to a novel peer for one study participant. These effects could be further evaluated, however, by examining the extent to which peer manding with PECS might generalize to the participants' natural environment (school or home) or to novel peers.

Both Paden et al. (2012) and Kodak et al. (2012) successfully taught children with autism to mand with their peers with ASD using an AAC system. Although a mand may not necessarily constitute a "true" social interaction, peer manding teaches children socially appropriate ways to gain access to preferred items from their peers (Taylor et al., 2005). Additionally, teaching peer manding may pair peers with reinforcement, potentially increasing the likelihood of further social interaction (Kodak et al., 2012). Although published research, such as Paden et al. (2012) and Kodak et al. (2012), formed peer pairs between children with ASD, the studies did not include data on the behavior of the recipient of the PECS exchange (the listener). This feature limited the conclusions that could be drawn about the ability of peers with ASD to respond appropriately to PECS mands in the absence of adult assistance. It is vital to teach peers with ASD to independently respond to peer PECS mands in order to prevent extinction of peer manding in the natural environment, to allow peer manding to occur in the absence of adult assistance,

and to begin to create a reciprocity that is present in a typical social interaction (Lorah, Gilroy, & Hineline, 2014; Paden et al., 2012).

In recent years, several studies have evaluated strategies to teach typically developing peers to respond correctly to PECS mands (e.g., Cannella-Malone, Fant, & Tullis, 2010; Thiemann-Bourque, 2012), whereas some studies have taught a peer with developmental disabilities to respond to PECS exchanges (e.g., Cannella-Malone et al., 2010). Such research allows peer manding to be reinforced in the natural environment. Thiemann-Bourque (2012), for example, conducted two nonexperimental pilot studies on teaching typically developing peers to respond to both PECS exchanges and speech-generating devices by providing five adult-directed instruction sessions of 30–45 min in duration. These sessions included adult-adult and adult-child role-play, corrective feedback, and reinforcement. Although this study demonstrated an increase in listener responses to peer mands, many young children with ASD may not have access to typically developing peers within early intervention settings. To date, a limited amount of research exists examining the effects of systematically teaching children with ASD to effectively respond to peer mands.

Using an interrupted chain procedure plus prompting, Lorah et al. (2014) trained children with ASD to mand for a missing puzzle piece from a peer with ASD using PECS at a tabletop. The peer with ASD was concurrently prompted to respond to the mand and give the requested puzzle piece. A break was then provided following a mand-response sequence. This study was effective in demonstrating a large increase in both peer mands and the responses to peer requests, thus extending the peer-manding literature between peers with ASD. There are some experimental manipulations, however, that may further extend the findings by Lorah et al. (2014). First, although this study demonstrated large increases in responses to peer requests for all participants, the authors did not include discrimination training in their research design. Because listeners (i.e., those who responded to peer mands) had one stimulus to exchange with their peer at any one time, the authors could not determine the degree to which the listeners discriminated between their peer's mand and the selection of the appropriate item for exchange. Additionally, reinforcement (a break from the table) was not thinned during this study. The effect of this study could be further evaluated by examining skill maintenance during the thinning of a reinforcement schedule. Also, as peer manding and responding were only taught during a single activity (puzzles), it may be beneficial to apply a similar protocol to evaluate responses to requests for a wider range of stimuli. Finally, due to their experimental design, the authors did not collect any baseline data on listener responding prior to intervention conditions, which may have limited the conclusions that could be made about a causal relationship.

The current studies had several objectives. The primary purpose of Study 1 was to teach children with ASD to direct PECS mands toward their peers. The aim was also to extend Paden et al. (2012) and Kodak et al. (2012) by investigating the consistency of this skill across peers and in the natural environment. The primary purpose of Study 2 was to determine whether systematic prompting with positive reinforcement was effective in teaching children with ASD to respond to peer PECS mands for a variety of stimuli. This study aimed to replicate and extend Lorah et al. (2014) by requiring participants to discriminate between an array of up to three stimuli when responding to a variety of peer mands. Additionally, this study also assessed generalization of responses to peer PECS mands across multiple peers and settings. The maintenance of responding to peers' PECS mands was also assessed, as the schedule of reinforcement was thinned for listeners. In doing so, these studies aimed to increase independent social interactions among children with ASD and allow more communication between children who use speech as their primary method of communication and children who primarily communicate using PECS.

Study 1

Method

Participants Three male children aged from 3 years 9 months to 4 years 3 months with a diagnosis of ASD participated in this study. These participants acted as *speakers* in this study, demonstrated a limited vocal repertoire, and used PECS as their primary method of communication. Speaker 1 was age 4 years 1 month. Standardized psychological and cognitive tests had been conducted 1 month prior to starting this study. According to the Vineland Adaptive Behavior Scales, Second Edition (Sparrow, Cicchetti, & Balla, 2005), Speaker 1 presented with low levels of communication (a score of 63), daily living (a score of 62), and social skills (a score of 66). According to the Wechsler Preschool and Primary Scale of Intelligence, Third Edition (Wechsler, 2002), the verbal IQ of Speaker 1 was in the borderline/low average range (a score of 77) and performance IQ in the extremely low range (a score of 73). Speaker 2 was age 4 years 3 months at the start of this study. Standardized cognitive tests had been conducted less than 8 months prior to starting this study. The Stanford–Binet Intelligence Scales, Fifth Edition (Roid, 2003), gave a nonverbal IQ in the borderline range of intelligence (a score of 78). Speaker 3 was age 3 years 9 months at the start of this study. The Bayley Scales of Infant and Toddler Development, Third Edition (Bayley, 2006), conducted less than a month prior to the start of the study, gave a borderline cognitive development score (70), an extremely low social-emotional development score (65), and an extremely low adaptive behavior score

(50). Class teachers reported that each of these children had completed up to Stage IIIb of PECS (Bondy & Frost, 2001) prior to the commencement of this study. None of the speakers were reported to initiate requests for preferred items with peers by PECS or any other means prior to the initiation of this intervention.

Setting This study took place in an applied behavior analysis preschool where all participants attended 5 days per week. Baseline and intervention sessions were conducted in a room within this school. Novel-environment probes were conducted in classrooms throughout the school (the participants' regular classroom) and included the presence of additional teachers and students.

Materials Parents and guardians completed a written questionnaire to determine a pool of potential reinforcers from categories such as edibles; tangibles; and sensory, social, and activity stimuli. Highly preferred target stimuli for speakers were also identified by verbal teacher report; teachers rated the five toys, edibles, and activities that speakers requested most often during their typical preschool day using PECS. This preference assessment method was chosen to ensure speakers had the ability to readily request target stimuli using PECS. It must be noted that it was deemed unfeasible to restrict access to the speakers' five most requested items across the entire school day, as the speakers in this study had a small pool of reinforcers. It was therefore ensured that speakers' preferred stimuli were restricted at least 20 min before study sessions to create an EO. Items present during study sessions included typical teaching materials (e.g., desks, chairs), preferred stimuli (toys, bubbles, electronics, and edibles), PECS cards (depicting preferred toys and edibles), distractor PECS cards (depicting non-highly preferred items, e.g., puzzles, a bead maze, blocks, books), a PECS binder, data-recording sheets, and a video camera with a tripod stand. A visual schedule (depicting a table, toys, a PECS book, and a way to indicate "yes" or "no") was also used with participants prior to study sessions to obtain ongoing consent vocally or pictorially.

Dependent Variable The dependent variable was independent peer-directed manding, defined as any instance where the speaker selects and hands a PECS card (either a target or distractor card) to a peer in the absence of prompts. Data were expressed as the percentage of independent peer-directed mands per session. This formula was calculated as the number of independent peer-directed mands divided by the number of independent peer-directed mands plus prompted peer-directed mands, multiplied by 100. Each study session consisted of 10 trials.

Interobserver Agreement An independent observer watched a videotape of sessions and recorded the participants' target responses during at least 33% of all sessions to assess

interobserver agreement (IOA). IOA was calculated on a trial-by-trial basis by dividing the number of agreements in a session by the total number of agreements plus disagreements and multiplying by 100 (Kazdin, 2010). The mean agreement for independent peer-directed manding for Speaker 1 was 97.2% (range 89%–100%), Speaker 2 was 97.3% (range 80%–100%), and Speaker 3 was 97.8% (range 90%–100%).

Design and Procedure All study sessions lasted approximately 10 min in duration and consisted of 10 trials. The three study participants were paired with a peer listener with ASD. Pairs sat adjacent to one another at a table within 1 m of each other, and one researcher sat behind or across from them at this table. For each speaker, five target PECS pictures (items that the speakers most frequently requested or consumed) and four distractor PECS pictures were used. Each of the five target PECS pictures were presented in a quasi-random order, with each target picture presented twice per session.

As with Paden et al. (2012), during each trial the teacher placed three leisure items or edibles (two distractor items and one target item) in front of or beside the peer listener while the corresponding PECS pictures were placed on the speaker's PECS binder. A nonexperimental design was used to investigate whether speakers' percentage of independent mands toward listeners increased. The specific procedures for study phases are detailed in the following sections.

Baseline Two baseline probes were conducted for all speakers prior to intervention and prior to the listener baseline detailed in Study 2. During baseline, the teacher did not prompt the speaker to select a PECS card. To avoid extinction of PECS requesting on the part of the speaker, if any speaker handed a PECS card to the teacher or the listener, the requested item was delivered to him by the teacher for 30 s. Prompts were not provided to listeners to take the card or deliver the requested item. If during any trial speakers did not select a PECS card within 30 s, the items were changed and a new trial started.

Least-To-Most (LTM) Prompting Once speakers had selected an item from their PECS binder, they were prompted to direct the PECS card toward their peer listener. Speakers were prompted to complete this response using an LTM prompt hierarchy with gradually more intrusive prompts delivered in 2- to 3-s intervals. The LTM prompt hierarchy was as follows: (a) a pointing (gestural) prompt, (b) guidance from the elbow (partial physical prompt), and (c) a hand-over-hand prompt (full physical prompt). Speakers then gained access to the requested item for 30 s or until the item had been consumed during each trial. The PECS cards were then immediately removed from their binder. If speakers requested a distractor item during any trial, they gained access to this item for 30 s. Once this exchange was completed, another three items/edibles were placed in front of the listener and the

corresponding PECS cards were placed on the PECS binder of the speakers. The process continued until 10 trials had elapsed. One intervention session was conducted per day for each speaker-listener pair.

Five-Second Time Delay (5-s TD; Speakers 2 and 3 Only) The procedures in this condition were identical to those described in the LTM prompting condition except that a 5-s TD was provided before speakers were prompted to direct the PECS mand toward listeners with the least intrusive prompt. This TD was introduced when LTM prompting alone was unsuccessful in increasing independent peer mands.

Most-To-Least (MTL) Prompting (Speakers 1 and 2 Only) In this condition, the teacher provided an immediate prompt once speakers had chosen a PECS card from the binder. Initially the most intrusive prompt was provided (full physical), then prompts were systematically faded following 90% accuracy over two consecutive sessions at a designated prompt level. The MTL prompt hierarchy was as follows: (a) a hand-over-hand prompt (full physical prompt), (b) guidance from the elbow (partial physical prompt), (c) a pointing (gestural) prompt, and (d) no initial prompt. MTL prompting was introduced partly due to time constraints in data collection and also as an attempt to reduce any errors that may have impaired speaker learning and subsequent task acquisition.

Additional Reinforcement for Independent Peer Mands (Speakers 2 and 3 Only) Additional reinforcement (in the form of edibles) was provided for speakers contingent upon independent peer mands. This additional reinforcement was given to speakers immediately following a PECS exchange with a listener and was delivered by the teacher. Therefore, contingent upon independent peer-directed mands, speakers gained access to both the requested item and an additional reinforcer. Additional reinforcement initially occurred on a fixed-ratio 1 (FR1) schedule. Following a single session demonstrating an accuracy level of 90% or higher, additional reinforcement for speakers was systematically faded (e.g., FR1 to variable-ratio 1 [VR1] to VR2). Whereas the criteria for fading prompts or thinning reinforcement throughout this study was set at two consecutive study sessions with accuracy levels of 90% or higher, the criteria for fading reinforcement was adjusted in this case due to time constraints. This approach was adopted because speakers were consistently manding for preferred items using PECS, but they directed their PECS mands toward the teacher.

Novel-Peer Probes Once responding displayed a relatively stable or increasing trend for speakers, probes were conducted to determine whether participants could initiate PECS mands with novel listeners (those in the other two pairs). These sessions were carried out as per the LTM condition.

Novel-Environment Probes Five additional probes were conducted to determine whether speakers would initiate PECS mands with novel listeners in a novel environment. The novel environment included a room in which speakers did not receive training and included the presence of other teachers and students.

During each trial, one to three leisure items or edibles were placed in front or in the hands of a novel listener who sat or stood 1–2 m away from the speaker. Speakers had access to their PECS binders, which contained pictures of the corresponding items. Similar to baseline, the teacher did not provide any prompting or assistance to the speakers to select a PECS card or direct the PECS card toward their peers. If speakers handed a PECS card to the teacher, the requested item was delivered to them by the teacher for 30 s. If speakers handed a PECS card to the novel listener, that listener was prompted to deliver the item to them for 30 s.

One-Month Follow-up One additional session was conducted for each speaker during a 1-month follow-up and run as per the original LTM conditions.

Results and Discussion

Figure 1 depicts the speaker data for Speakers 1, 2, and 3 during baseline, multiple intervention conditions, novel-peer probes, novel-environment probes, and during a 1-month follow-up session. During two speaker baseline probes, all speakers displayed zero levels of peer-directed PECS mands. All mands were directed toward adults during these probes.

During LTM prompting, Speaker 1 displayed a moderate increase in the percentage of independent peer-directed mands (ranging from 40% to 60% independence levels). During Sessions 6 and 7, however, Speaker 1 was observed to forcefully pull back the PECS card or fail to release the PECS card on several trials. MTL prompting was employed from Session 7 onward to block this behavior, and prompts were faded over subsequent trials. By Sessions 16 and 17, Speaker 1 independently initiated mands toward Listener 1 with 89%–90% independence. With the exception of a temporary reduction of independent peer mands during Sessions 21–23, Speaker 1 displayed high but variable levels of independent peer mands. Study pairs were also mixed to determine whether peer manding would be consistent across novel trained listeners. During two probe sessions with trained listeners from other pairs, Speaker 1 demonstrated peer mands with 100% independence. Additionally, during five novel-environment probe trials (in the child's regular classroom), Speaker 1 directed mands toward peers during 100% of trials. Finally, Speaker 1 also maintained performance at 100% during a 1-month follow-up session.

Fig. 1 The percentage of independent peer-directed mands for Speakers 1, 2, and 3. R+ = reinforcement for independent mands condition; FP = full physical prompt; PP = partial physical prompt; GP = gestural prompt; FR–VR = additional reinforcement schedule for independent peer mands from an FR schedule to a VR schedule. MTL prompts were faded with accuracy levels of 90% or more during two consecutive sessions (Speakers 1 and 2 only). Additional reinforcement for independent peer mands was faded with accuracy levels of 90% or more during a single session. FR–VR signifies the reinforcement schedule in place at any time (Speakers 2 and 3 only)

Speaker 2 displayed no change in responding after four LTM sessions. A 5-s TD was then introduced, leading to a minimal increase in responding where data remained variable for five sessions. An MTL prompt hierarchy was introduced in

Session 12 and systematically faded. Following a return to the LTM prompting conditions, additional reinforcement in the form of edibles was provided for all occurrences of independent peer mands, which produced an increase in responding. Speaker 2 displayed relatively stable and high levels of responding (89%–100%) as additional reinforcement for independent peer mands was systematically thinned from an FR1 to a VR9 schedule of reinforcement (Sessions 24–31). Responding remained at 100% accuracy levels even when additional reinforcement for independent mands was completely faded (Session 32). When paired with trained novel listeners, Speaker 2 displayed a high percentage of independent peer mands (90% and 88%), and Speaker 2 also maintained an accuracy level of 100% during a 1-month follow-up session. Due to an absence from school, no formal novel-environment probes were conducted with Speaker 2.

As Speaker 3 also displayed zero levels of responding after four intervention trials using LTM conditions, a 5-s TD was also introduced before prompts were provided to mand toward Listener 3. This strategy initially led to a minimal and variable increase in levels of independent manding (Sessions 7–10). Due to time constraints and the lack of success with Speaker 2, an MTL prompting strategy was not attempted. Instead, during Sessions 11–16, additional reinforcement in the form of edibles was introduced contingent upon independent peer mands. This was followed by increased responding. Speaker 3 also maintained relatively high levels of independent responding (80%–100%) as additional reinforcement for independent peer mands was systematically thinned from an FR1 to a VR3 schedule of reinforcement. Speaker 3 demonstrated high levels of independent peer mands when paired with trained novel peers (100% accuracy) and during a 1-month follow-up probe (90% accuracy). During novel-environment probes, Speaker 3 directed mands toward peers during 0% of trials. During these trials, Speaker 3 instead directed mands toward adults, which were then honored. Anecdotal classroom reports noted, however, that when adult listeners were unavailable, Speaker 3 began to direct PECS cards toward peers.

As seen previously, Speakers 2 and 3 were unresponsive to LTM intervention conditions alone and the addition of a 5-s TD also failed to produce a steady increase in peer PECS mands. MTL prompting also proved ineffective for Speaker 2. It is possible that this lack of independent responding may have been due in part to a strong history of reinforcement of mands with adults both in the natural environment and during the baseline procedures employed within this study. During two speaker baseline probes and extensive listener baseline sessions, if the listener did not respond to peer PECS mands correctly, the adult delivered access to reinforcement. Future research may want to train listeners to respond to adult mands first to remove the need for extensive baseline sessions where

mands are likely to be honored by adults alone. Results of this study suggested, however, that additional reinforcement (in the form of edibles) for independent mands may have led to an increase in independent peers mands for both Speakers 2 and 3.

It should also be noted that there was an inconsistent number of sessions conducted for each procedural change during intervention across speakers. As Speakers 2 and 3 did not learn to direct PECS mands toward their peers using LTM conditions, described previously, several experimental changes were utilized to aid skill acquisition. There were no set criteria, however, to make these changes across speakers and this was often due to time constraints. Instead, changes were made on a case-by-case basis, typically following at least four sessions with no change in responding.

Study 2

Method

Participants Three male children aged between 3 years 11 months and 5 years with a diagnosis of ASD participated in this study. These participants acted as *listeners* in this study. Listener 1, age 3 years 11 months, and Listener 2, age 4 years 11 months, had vocal ability and did not require an AAC system to communicate. Listener 1 could spontaneously communicate using two- to three-word sentences. He could respond to his name and social routines such as “hi” and “bye” from peers and adults. He could follow simple one-step directions and motor instructions without prompts. From a social play perspective, he required prompts to demonstrate turn-taking and sharing skills. No formal cognitive assessments or standardized tests were available for this participant. Listener 2 could spontaneously communicate using three- to five-word sentences. He could respond to his name and social routines such as “hi” and “bye” from peers and adults. He could follow simple one-step directions and motor instructions without prompts. From a social play perspective, he could take turns and would share with his peers. Standardized psychological assessments were conducted less than 8 months prior to the study. According to the Reynell Developmental Language Scales, Third Edition (Edwards et al., 1997), Listener 2 displayed comprehension skills in the severe range (a score of 23, which was in the 1st percentile) and expressive language skills in the severe range (a score of 26, which was in the 1st percentile). Listener 3, age 5 years, communicated vocally using some single words and PECS. He could respond to his name and social routines such as “hi” and “bye” from peers and adults. He could follow simple one-step directions and motor instructions without prompts. From a social play perspective, he required prompting to take turns and did not share with his peers. No formal cognitive

assessments or standardized tests were available for this participant. None of these listeners were observed to respond to peer PECS mands in the natural environment prior to this intervention.

Setting This study took place in an applied behavior analysis preschool where all participants attended 5 days per week. Baseline and intervention sessions were conducted in a room within this school. Natural-environment probes were conducted in classrooms throughout the school (the participants' regular classroom) and included the presence of additional teachers and students.

Materials Parents and guardians had completed a written questionnaire to determine a pool of potential reinforcers from categories such as edibles, tangibles, sensory reinforcers, social reinforcers, and activity reinforcers. The listeners' highly preferred stimuli were then identified prior to this intervention via paired-stimulus preference assessments using the procedure described by Fisher et al. (1992). The two items determined to be most preferred by listeners were restricted during the school day to increase the likelihood that they would serve as reinforcers. All other materials are the same as those detailed in Study 1.

Dependent Variable The dependent variable was correct independent responses to a PECS exchange, defined as any instance where the listener takes a PECS card (either a target or distractor card) from a peer and gives the requested item within 5 s in the absence of prompts. This was calculated as the number of correct responses in a session divided by the number of correct plus incorrect responses in a session, multiplied by 100%.

IOA An independent observer watched a videotape of experimental sessions and recorded the participants' target responses during at least 33% of all sessions to assess IOA. IOA was calculated on a trial-by-trial basis by dividing the number of agreements in a session by the total number of agreements plus disagreements and multiplying by 100 (Kazdin, 2010). The mean agreement for correct independent responses to PECS exchanges for Listener 1 was 97.7% (range 80%–100%), for Listener 2 was 98.7% (range 90%–100%), and for Listener 3 was 98.6% (range 89%–100%).

Design and Procedure A multiple-baseline across-participants (listeners) design was used to assess the effects of prompting and positive reinforcement on the percentage of independent responses to mands from peers using PECS. The session length, number of trials, setting, and materials used were the same as detailed in Study 1. The listeners in this study were also paired with the speakers detailed in Study 1.

Baseline Once speakers selected an item from their PECS binder, they were physically prompted to direct the PECS card toward the listener for 5 s as described in Study 1. The listener was not prompted to take the PECS card or deliver the requested item. If the listener completed these steps independently, reinforcement was not provided. If the listener did not respond or responded incorrectly, the requested item was delivered to the speaker by the teacher for 30 s. Following this trial, another three items were placed in front of the listener and the corresponding PECS cards were placed on the PECS binder of the speaker. Intervention conditions were introduced once each listener demonstrated at least three stable data points during baseline conditions.

Intervention Once speakers had selected an item from their PECS binders, they were prompted to direct the PECS picture toward the listener (see Study 1 for details). If listeners did not take the card and begin to deliver the requested item within 3 s, or if they started to make an error (e.g., delivering an item that was not requested by the speaker), they were prompted to complete the correct response (both to take the card and deliver the correct requested item) using an MTL prompt hierarchy. The MTL prompt hierarchy was as follows: (a) a hand-over-hand prompt (full physical prompt), (b) guidance from the elbow (partial physical prompt), (c) a pointing (gestural) prompt, and (d) no initial prompt. Listeners started with a full physical prompt in the MTL prompt hierarchy, and once they responded either independently or at the designated prompt level during 90% of trials over two consecutive sessions, they were moved to a less intrusive prompt level. If listeners did not respond either independently or at the designated prompt level during at least 40% of trials for two consecutive sessions, they were moved back to a more intrusive prompt level. Once listeners had taken the card and placed the requested item in front of the speaker either independently or at the designated prompt level, the teacher gave listeners immediate verbal praise and access to a preferred toy/edible for 30 s or until the item was consumed. When delivering the requested item, the listeners were required to place the requested item in front of their peers. It was decided that the listeners were not required to place the item in their peers' hands because larger toys were difficult for children to carry. At the end of this 30-s interval, the teacher gave a 5-s count and removed the reinforcer. Reinforcement initially occurred on an FR1 schedule. Once listeners had achieved two consecutive sessions with accuracy levels of 90% or higher, reinforcement for listeners was faded systematically (e.g., FR1, FR2, VR1, VR2, and VR3). After each exchange, another three items/edibles were placed in front of the listener and the corresponding PECS cards were placed on the PECS binder of the speakers by the researcher. The process continued until 10 trials had elapsed. One intervention session was conducted per day for each pair.

Probes of Listener Behavior across Trained Peers Once responding displayed a relatively stable or increasing trend for listeners, probe sessions were conducted to assess the consistency of responding to PECS mands across trained peers (those in the other two pairs). During these probe sessions, each trained speaker was placed with a trained listener from another study pair. These sessions were carried out as per intervention conditions.

Natural-Environment Probes Five additional natural-environment probes were conducted to assess for the occurrence of responding to PECS exchanges in a novel setting and across a range of novel untrained speakers in their typical school classroom. These probes included the presence of other teachers and students.

Listeners sat or stood with two to four leisure items in front of or beside them. A novel PECS user was prompted by the teacher to hand the listener a PECS card. Tangible and edible reinforcement was not provided during these probe sessions for correct responses. If the listener did not respond appropriately within 5 s, the teacher took the PECS card and delivered the requested item to the speaker. No prompts were provided to the listener to complete the required response.

One-Month Follow-up One additional session was conducted during a 1-month follow-up for all listeners and run as per original intervention conditions.

Results and Discussion

Figure 2 depicts the data for Listeners 1, 2, and 3 across baseline, intervention, novel-peer probes, novel-environment probes, and at a 1-month follow-up. During baseline, Listeners 1 and 3 displayed zero levels of responding to PECS exchanges, whereas Listener 2 displayed near-zero levels of responding. During the intervention phase of MTL prompting plus reinforcement, all participants displayed an increase in responding to PECS exchanges on an FR1 schedule of reinforcement.

Apart from Session 34, where Listener 1 demonstrated noncompliance during this study session, correct independent responses to PECS exchange in Listeners 1 and 2 remained relatively high (typically demonstrating over 85% independence as reinforcement was faded from an FR1 schedule of reinforcement to a VR6 schedule of reinforcement, a reinforcement schedule that would likely be quite practical in a typical classroom environment). Study pairs were mixed to determine whether responding was consistent across novel trained speakers. Prior to conducting any novel-peer probes, all participants had previously achieved accuracy levels of 90% or more at an FR1 level of reinforcement. When paired with two novel trained speakers, Listeners 1 and 2 both

Fig. 2 Percentage of correct independent responses to PECS exchange for all listeners. Reinforcement for correct independent responses was faded contingent on two consecutive sessions with 90% accuracy levels or more

displayed high levels of independent responding to PECS exchanges (between 90% and 100%). Listeners 1 and 2 displayed 100% accuracy levels during novel-environment probes and demonstrated accuracy levels of over 80% at a 1-month follow-up probe. These results are suggestive of generalization across people and environments and show skill maintenance.

The data for Listener 3, however, displayed a more variable trend. Although data initially demonstrated a stable ascending trend, there was some variability in later sessions (38 and 41),

potentially due to a training gap due to participant absence during Sessions 33–38. Responding to PECS exchanges remained above 80% accuracy as reinforcement was faded to a VR1 schedule of reinforcement. When Listener 3 was paired with two novel trained speakers, however, he displayed a sharp decrease of responding (57%–69%) and exhibited inconsistent responding in a novel environment with 60% accuracy levels. Responding remained above 80% during a 1-month follow-up, however.

General Discussion

Consistent with past peer-manding research (Kodak et al., 2012; Paden et al., 2012; Pellecchia & Hineline, 2007; Taylor et al., 2005), Study 1 demonstrated that PECS mands did not generalize to peers in the absence of training. As the effect of LTM prompting in the presence of an EO on teaching independent peer mands was inconsistent across participants, several intervention modifications were required for speakers within this study to establish a strong peer mand repertoire. Although the data were nonexperimental, results suggested that peer PECS mands can be taught across a variety of trained peers and that this skill may generalize to the natural environment. Due to a lack of baseline probes, generalization could not be explicitly demonstrated. Promisingly, participants also displayed skill maintenance at a 1-month follow-up session.

Study 1 is not without limitation. First, as experimental data were not taken on speakers' PECS proficiency with adults prior to the onset of the study, it is possible that PECS users were less proficient than reported. Additionally, although additional reinforcement for independent peer manding appeared to be an effective strategy to increase independent peer mands, further formal preference assessment should have been conducted prior to implementing this study phase. It is possible that more potent reinforcers alone may have improved responding. According to staff reports, however, reinforcers used within this study continued to be the speakers' most highly requested in the natural environment. In addition, a true mand should be under the control of motivating operations and be directly reinforced by the requested item (Skinner, 1957). Additional reinforcement, however, was quickly thinned to come under the control of natural forms of reinforcement (i.e., receiving the requested stimulus). Future research may consider identifying highly potent reinforcers that are only made available contingent upon manding to peers to increase the motivation to interact with peers.

The most significant limitation, however, was the lack of experimental control in Study 1. Unfortunately, it was not feasible to conduct a multiple-baseline design for Study 1 because speakers required prompts to hand a PECS card to a peer listener during the listener baseline in Study 1. Quite possibly, listeners may have reinforced the mand during this phase.

The overall results of Study 2 indicate that children with ASD can be taught to respond to peer PECS mands using MTL prompting with a TD and positive reinforcement. This protocol was successful not only in the acquisition of responding to peer PECS mands but also for its maintenance over time. Promisingly, independent responding to PECS mands also remained relatively high as reinforcement was systematically thinned. To extend upon past research conducted by Lorah et al. (2014), listener discrimination was incorporated into this study design, and peer listeners with an ASD diagnosis were successfully taught to discriminate between an array of three items when responding to PECS mands. Data were not taken on the types of errors made by listeners; however, verbal reports noted that errors frequently involved delivering an incorrect item or failing to take the PECS card in the absence of prompts.

Study 2 also examined the consistency of responding across novel peers and a novel environment. Promisingly, two out of three listeners were consistent in responding to PECS mands when placed with novel trained speakers from Study 1. This study also had the advantage of performing novel-environmental probes in the participants' natural environment rather than a contrived experimental setting like past studies (e.g., Kodak et al., 2012). During novel-environmental probes, two out of three listeners also readily demonstrated the skill of responding to peer PECS mands in the natural environment with two novel untrained peers, suggestive of generalization. Although the lack of baseline generalization probes do not allow generalization to be explicitly demonstrated, verbal teacher reports noted that participants were not observed to respond to peer PECS mands in the natural environment prior to the study.

Although findings from Study 2 extend upon the current literature on peer manding and responding using PECS, it is also not without its limitations. In Study 2, listeners were given a PECS picture and required to discriminate between three items in front of them (one target item and two distractor items). Although listeners successfully demonstrated this skill, speakers rarely requested distractor stimuli, weakening the demonstration of true discrimination. It is possible that listeners may have learned by excluding distractor stimuli. To ameliorate these potential effects, all stimuli were changed each session. In addition, listeners also demonstrated consistency of responding across novel speakers who had different target and distractor stimuli. Nevertheless, future research should consider discrimination using an array of only preferred items.

Another limitation is that data on the cognitive levels of listeners were not available to researchers. It is possible that there may have been a significant difference in the cognitive abilities between the participants of Study 2 and those of Lorah et al. (2014), impacting on the ability to respond to peer-directed PECS mands.

In conclusion, the findings of Study 1 may guide future peer-manding research due to the demonstration of peer manding across a range of peers for all participants and in a novel environment for one participant. Regarding Study 2, although recent research has investigated peer manding using PECS in children with ASD, there has been a limited focus on teaching peers with ASD to respond correctly and independently to PECS mands. Responding to peer mands is a vital skill to teach, as it is likely to prevent the extinction of peer manding in the natural environment and allow a mand to take place in the absence of adult assistance. The results of Study 2 have demonstrated success in establishing the skill of responding as listeners to PECS mands and showing its maintenance over time and consistency across peers and settings. Furthermore, reinforcement can be faded to a practical level while still maintaining independence. Although the interactions in Studies 1 and 2 may not have been reciprocal, on a practical level, this study has demonstrated an intervention package that has been successful in increasing independent social interactions between six children with a diagnosis of ASD by using short daily manding sessions.

Acknowledgements The authors would like to thank the participants and their families for their part in this study. We would also like to acknowledge the contribution of the staff of PALS preschool for their part in conducting study trials and data collection.

Compliance with Ethical Standards

Conflict of Interest Amanda Doherty and Laura Gormley were employed by the host institution at the time of the study.

Ethical Approval All procedures performed in the study were in accordance with the ethical standards of the School of Psychology Ethics Committee of Trinity College Dublin, and with the 1964 Helsinki declaration and its later amendments.

Informed Consent Informed consent and assent was obtained from all individuals and their parents/guardians in the study.

References

- Bayley, N. (2006). *Bayley scales of infant and toddler development: Administration manual* (3rd ed.). San Antonio, TX: Harcourt Assessment.
- Belchic, J. K., & Harris, S. L. (1994). The use of multiple peer exemplars to enhance the generalization of play skills to the siblings of children with autism. *Children and Family Behavior Therapy*, 16(2), 1–25. https://doi.org/10.1300/J019v16n02_01.
- Bondy, A., & Frost, L. (2001). The picture exchange communication system. *Behavior Modification*, 25(5), 725–744. <https://doi.org/10.1177/0145445501255004>.
- Cannella-Malone, H. I., Fant, J. L., & Tullis, C. A. (2010). Using the picture exchange communication system to increase the social communication of two individuals with severe developmental disabilities. *Journal of Developmental and Physical Disabilities*, 22(2), 149–163. <https://doi.org/10.1007/s10882-009-9174-4>.
- DiSalvo, C., & Oswald, D. (2002). Peer-mediated interventions to increase the social interaction of children with autism: Consideration of peer expectancies. *Focus on Autism and Other Developmental Disabilities*, 17(4), 198–207. <https://doi.org/10.1177/10883576020170040201>.
- Edwards, S., Fletcher, P., Garman, M., Hughes, A., Letts, C., & Sinka, I. (1997). *The Reynell developmental language scales* (3rd ed.). Windsor, UK: NFER-Nelson.
- Fisher, W. W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, 25, 491–498. <https://doi.org/10.1901/jaba.1992.25-491>.
- Gonzalez-Lopez, A., & Kamps, D. M. (1997). Social skills training to increase social interactions between children with autism and their typical peers. *Focus on Autism and Other Developmental Disabilities*, 12(1), 2–14. <https://doi.org/10.1177/108835769701200101>.
- Hancock, T. B., & Kaiser, B. (1996). Siblings' use of milieu teaching at home. *Topics in Early Childhood Special Education*, 16(2), 168–190. <https://doi.org/10.1177/027112149601600204>.
- Kazdin, A. E. (2010). *Single-case research designs: Methods for clinical and applied settings*. New York, NY: Oxford University Press.
- Kodak, T., Paden, A., & Dickes, N. (2012). Training and generalization of peer-directed mands with non-vocal children with autism. *The Analysis of Verbal Behavior*, 28(1), 119–124. <https://doi.org/10.1007/BF03393112>.
- Koegel, L. K., Park, M. N., & Koegel, R. L. (2014). Using self-management to improve the reciprocal social conversation of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 44(5), 1055–1063. <https://doi.org/10.1007/s10803-013-1956-y>.
- Lorah, E. R., Gilroy, S. P., & Hinline, P. N. (2014). Acquisition of peer manding and listener responding in young children with autism. *Research in Autism Spectrum Disorders*, 8(2), 61–67. <https://doi.org/10.1016/j.rasd.2013.10.009>.
- Michael, J. (1993). Establishing operations. *The Behavior Analyst*, 16(2), 191–206. <https://doi.org/10.1007/BF03392623>.
- Paden, A. R., Kodak, T., Fisher, W. W., Gawley-Bullington, E. M., & Boussein, K. J. (2012). Teaching children with autism to engage in peer-directed mands using a picture exchange communication system. *Journal of Applied Behavior Analysis*, 45(2), 425–429. <https://doi.org/10.1901/jaba.2012.45-425>.
- Pellecchia, M., & Hinline, P. N. (2007). Generalization of mands in children with autism from adults to peers. *The Behavior Analyst Today*, 8(4), 483–491. <https://doi.org/10.1037/h0100634>.
- Roid, G. H. (2003). *Stanford–Binet intelligence scales* (5th ed.). Itasca, IL: Riverside.
- Skinner, B. F. (1957). *Verbal behavior*. New York, NY: Appleton-Century-Crofts.
- Sparrow, S., Cicchetti, D. V., & Balla, D. A. (2005). *Vineland adaptive behavior scales* (2nd ed.). Circle Pines, MN: AGS Publishing.
- Taylor, B. A., Hoch, H., Potter, B., Rodriguez, A., Spinnato, D., & Kalaigian, M. (2005). Manipulating establishing operations to promote initiations towards peers in children with autism. *Research in Developmental Disabilities*, 26(4), 385–392. <https://doi.org/10.1016/j.ridd.2004.11.003>.
- Thiemann-Bourque, K. (2012). Peer-mediated AAC instruction for young children with autism and other developmental disabilities. *SIG 12 Perspectives on Augmentative and Alternative Communication*, 21(4), 159–166. <https://doi.org/10.1044/aac21.4.159>.
- Wechsler, D. (2002). *Wechsler preschool and primary scale of intelligence* (3rd ed.). San Antonio, TX: Harcourt Assessment.