

PECSperts! Exploring Child and Caregiver Outcomes Following Participation in a Brief
Communication Camp

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Abstract

Children with neurodevelopmental disorders, such as autism spectrum disorder (ASD), often have communication impairments. As a result, augmentative and alternative communication systems such as the Picture Exchange Communication System[®] (PECS[®]; Frost & Bondy, 2006) are often recommended. Although substantial evidence supports child PECS use, and emerging evidence supports caregiver PECS training, no research specifically explores brief caregiver and child PECS training models. As such, little is known about how to effectively train caregivers and children in an efficient manner. Further, few studies investigate whether caregivers and children generalize and maintain their PECS skills. This study explored child PECS accuracy and caregiver PECS treatment integrity following participation in a brief, 1-week caregiver and child PECS training camp that included caregiver training, child teaching, and caregiver-child coaching. Eight children diagnosed with ASD and their caregivers participated. A pre-post group design was implemented to assess caregiver and child performance in camp-clinic and home settings over time. Results suggest that average caregiver PECS treatment integrity and child PECS accuracy increased from pre- to post-intervention and caregiver treatment integrity remained stable during maintenance assessments. In contrast, child PECS accuracy was variable during maintenance assessments. Results were similar in both the camp-clinic and home settings for caregivers and children. These results indicate that a brief PECS training camp may improve caregiver and child PECS skills in both camp-clinic and home settings.

Keywords: PECS, caregiver training, camp, brief intervention, autism spectrum disorder

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Autism Spectrum Disorder

Over the last 50 years, autism spectrum disorder (ASD) has transformed from a rare childhood disorder to a commonly diagnosed, publicized condition (Lord et al., 2018). The core features of this neurodevelopmental disorder are separated into two domains for diagnostic purposes (American Psychiatric Association, 2013). The first domain includes social communication and interaction deficits, whereas the second includes restricted, and repetitive patterns of activities, interests, and behaviours (American Psychiatric Association, 2013). To diagnose ASD, there are certain criteria that need to be met. In terms of social communication and interaction symptoms, the first criterion includes deficits in social-emotional reciprocity, including decreased sharing of interests and emotions, and difficulties engaging in social interactions. The next criterion is deficits in nonverbal communicative behaviours, such as a lack of understanding of body language, eye contact, and facial expressions. The third criterion is deficits in social contexts including difficulties developing and maintaining relationships (American Psychiatric Association, 2013). In terms of restricted, and repetitive patterns of activities, interests, and behaviours, two of four criteria must be present for diagnosis. These criteria include: (a) repeated speech, physical movements, or use of objects in specific patterns, (b) following established routines in a rigid manner, (c) fixation on specific interests, or (d) heightened or reduced sensitivity to environmental sensory stimuli (American Psychiatric Association, 2013). Although there have been advances in ASD intervention throughout the years, approximately 33% to 50% of autistic people¹ do not develop functional speech (i.e., the

¹ Both person first and disability first language are used throughout this paper to be considerate of all preferences.

ability to use vocal language effectively to interact with others in the environment in a meaningful way; Horovitz & Matson, 2010; National Research Council, 2001). Children as young as 12 months old may be described as having communication deficits (Horovitz & Matson, 2010). Since many autistic people have social and communication deficits, it is important that they develop methods to interact with others in their environment and build relationships in the community. Augmentative and alternative communication (AAC) systems are often introduced to meet this objective.

Picture Exchange Communication System® (PECS®)

The Picture Exchange Communication System (PECS) is an AAC system created by Bondy and Frost (1994) that is used to improve social and functional communication skills (e.g., Bondy & Frost, 1994; Carre et al., 2009; Lerna et al., 2012; Lerna et al., 2014; Sulzer-Azaroff et al., 2009). As noted earlier, people on the autism spectrum may have socially related communication deficits (e.g., do not approach others to communicate, avoid social interactions, only communicate when cued to do so; Frost & Bondy, 2002). However, with appropriate supports and effective learning strategies, autistic people can learn to use PECS to engage in meaningful interactions such as socially approaching, reciprocating, and engaging with other individuals in the environment. PECS is specifically beneficial for people diagnosed with ASD as there are no prerequisites and studies have reported that PECS can enhance speech development (e.g., Silverman, 1995). Additional positive outcomes of PECS involve increases in appropriate play (e.g., Anderson et al. 2007; Charlop-Christy et al. 2002; Jurgens et al. 2009) and decreases in problem behaviour (e.g., Charlop-Christy et al., 2002; Frea et al., 2001). The PECS protocol includes six phases, and the following materials are required: a communication binder, sentence strip, pictures, and preferred/neutral items. The first phase involves a PECS user

handing a communicative partner a picture in exchange for an item or activity they desire. In phase 2 the distance increases between the PECS user, communication binder, and communicative partner. In the next phases, 3a and 3b, PECS users learn to discriminate between pictures, beginning with simple discrimination between two pictures (one of a preferred item, one of a non-preferred/neutral item) and progressing to complex discrimination amongst many pictures of preferred items and activities. In phase 4 the PECS user learns how to arrange pictures on a sentence strip to form a sentence. Phase 5 involves the PECS user learning to respond to simple questions and phase 6 involves learning how to make comments (Frost & Bondy, 2002). These phases are further described in Appendix A.

PECS Child Teaching

According to the National Professional Development Centre on Autism Spectrum Disorder and the Autism Evidence-Based Practice Review Group, PECS is considered an evidence-based practice for people diagnosed with ASD (Hume et al., 2021; Sam & AFRIM Team, 2016). As described earlier, numerous studies report positive child outcomes following PECS training (e.g., Carre et al., 2009; Carr & Felce, 2007; Charlop-Christy et al., 2002; Cummings et al., 2012; Koudys et al., 2021; Lerna et al., 2012). Some studies use group research designs, such as randomized controlled trials (e.g., Howlin et al., 2007), pre-post designs (e.g., Koudys et al., 2021), or experimental designs (e.g., Lerna et al., 2012) to evaluate PECS outcomes, whereas others use single case experimental designs, such as multiple baseline across participant designs (e.g., Carre et al., 2009; Charlop-Christy et al., 2002; Dogoe et al., 2010; Greenberg et al., 2012; Park et al., 2011), multiple baseline across behaviour designs (e.g., Cummings et al., 2012), multiple probe designs (e.g., Odluyurt et al., 2016), alternating treatment designs (e.g., Jurgens et al., 2019), or changing criterion designs (e.g., Yoon et al., 2017).

Within these research studies, many authors report teaching PECS to people with communication deficits using the training manual created by Bondy and Frost (1994; e.g., Carre et al., 2009; Carr & Felce, 2007; Charlop-Christy et al., 2002; Greenberg et al., 2012; Lerna et al., 2012). The training manual provides detailed descriptions of the procedures required to teach each phase of PECS (e.g., use of backward chaining and physical prompts provided by a second trainer to support the picture exchange in phase 1). The manual also provides general recommendations to create communication opportunities across the day in a variety of common routines. However, the authors do not provide specific recommendations for the length of PECS teaching sessions, the ideal number of sessions and/or trials per session, or the duration of intervention. Therefore, although the phase-specific teaching procedures are described in the manual—and are reported to be used in many published research studies—there is still substantial variability in the general approach to PECS teaching in the literature. For example, the length of PECS teaching sessions ranges from 15 mins (e.g., Charlop-Christy et al., 2002; Dogoe et al., 2010; Greenberg et al., 2012; Howlin et al., 2007), 20 mins (e.g., Yoon, 2017), 30 mins (e.g., Lerna et al., 2012), 1 hr (e.g., Carr & Felce, 2007), to 6 hrs (e.g., Koudys et al., 2021). In contrast, other studies do not describe the length of their teaching sessions (e.g., Carre et al., 2009; Cummings et al., 2012; Odluyurt et al., 2016). In terms of the number of sessions conducted per day, some studies report teaching one session per day (e.g., Charlop-Christy et al., 2002; Howlin et al., 2007; Lerna et al., 2012; Yoon, 2017), two or more sessions per day (e.g., Carr & Felce, 2007; Cummings et al., 2012), or a varying number of sessions per day (e.g., Greenberg et al., 2012). Other studies do not report using sessions; rather they report teaching PECS across the duration of the participants' time at school or in camp (e.g., Carre et al., 2009; Koudys et al., 2021). Although some literature describes that PECS teaching was conducted

between two to three days per week (e.g., Charlop-Christy et al., 2002; Dogoe et al., 2010; Lerna et al., 2012), three to four days per week (e.g., Carr & Felce, 2007), or four to five days per week (e.g., Carre et al., 2009; Koudys et al., 2021), other studies are less specific and describe that the number of days per week varied between two to five depending on the week (e.g., Yoon, 2017). In addition, the total duration of intervention differs between studies in the literature. For example, some studies report a total duration of approximately 11 (e.g., Charlop-Christy et al., 2002; Odluyurt et al., 2016), 17 (e.g., Dogoe et al., 2010), or 29 sessions (e.g., Cummings et al., 2012). Others report a longer duration such as 46 (e.g., Yoon, 2017), between 36 and 62 (e.g., Greenberg et al., 2012), or 72 sessions (e.g., Lerna et al., 2012). Koudys et al. (2021) reported their intervention lasted approximately 28 days; however, as previously noted, did not report using sessions. Similarly, Carr and Felce (2007) did not report on the total number of sessions, but rather, reported that their intervention was a total of 15 hrs across 5 weeks. Further, the duration of some interventions is unclear (e.g., Carre et al., 2009; Howlin et al., 2007), making it difficult to use these studies as a comparison. The number of trials conducted in each intervention also varies in the literature. The reported total number of trials ranges from approximately 91 (e.g., Lerna et al., 2012), 246 (e.g., Charlop-Christy et al., 2002), 503 (e.g., Greenberg et al., 2012), 520 (e.g., Cummings et al., 2012), to 723 (e.g., Yoon, 2017). Other studies do not report on the total number of trials conducted (e.g., Carre et al., 2009; Carr & Felce, 2007; Dogoe et al., 2010; Koudys et al., 2021; Howlin et al., 2007; Odluyurt et al., 2016). The variability in the general approach to PECS teaching (i.e., length of teaching sessions, number of sessions and/or trials/session, duration of intervention) makes it difficult to identify an approach to teaching PECS that is both efficient and effective.

Skill generalization is critical to the successful use of PECS as a functional communication system. Generalization refers to the extent to which a learner emits a target behaviour in an untrained setting or in the presence of an untrained stimulus that is different from the original instructional setting or stimulus (Cooper et al., 2020). A crucial component of PECS is the ability of PECS users to generalize the use of the system to the natural environment, in daily routines, with common stimuli and natural communicative partners (Frost & Bondy, 2002). However, in the literature, it is not clear how best to facilitate generalization to additional stimuli, communicative partners, and settings. Some studies report on generalization (e.g., Carre et al., 2009; Dogoe et al., 2012; Greenberg et al., 2012; Jurgens et al., 2012; Koudys et al., 2021; Yoon, 2017), compared to others that do not (e.g., Charlop-Christy et al., 2002; Cummings et al., 2012; Howlin et al., 2007; Lerna et al., 2012). Of the studies that report on generalization, outcomes are variable. Several studies report that PECS use generalized across stimuli (e.g., Chaabane et al., 2009), communicative partners (e.g., Greenberg et al., 2012; Park et al., 2011), and settings (e.g., Dogoe et al., 2010; Greenberg et al., 2012; Koudys et al., 2021), whereas other studies suggest that PECS use did not generalize to other settings (e.g., Carre et al., 2009; Jurgens et al., 2012; Yoon, 2017) and communicative partners (e.g., Yoon, 2017).

There are numerous approaches used to facilitate generalization across settings. For example, several studies (e.g., Dogoe et al., 2010; Koudys et al., 2021) report the successful use of multiple exemplar training (MET)—a method of training that uses multiple stimuli samples to facilitate responding to untrained, novel stimuli that may be encountered in natural environments post-training (Greer et al., 2005). Teaching across different environments was another approach used to facilitate generalization to new settings. Many studies strictly taught PECS in school/therapy-based settings (e.g., Carre et al., 2009; Cummings et al., 2012; Greenberg et al.,

2012; Lerna et al., 2012; Odluyurt et al., 2016; Howlin et al., 2007) or in home-based settings (e.g., Yoon, 2017). Other studies taught PECS in a combination of one or more of the following settings: school/therapy rooms, churches, community, and/or home (e.g., Charlop-Christy et al., 2002; Dogoe et al., 2012; Koudys et al., 2021). Frost and Bondy (2002) recommend teaching PECS across the day in numerous settings and activities to promote generalization. In contrast to facilitating generalization by teaching using MET and/or across settings, many studies do not specifically program for generalization (e.g., Carre et al., 2009; Cummings et al., 2012; Greenberg et al., 2012; Jurgens et al., 2012; Lerna et al., 2012; Odluyurt et al., 2016; Howlin et al., 2007; Yoon, 2017). The lack of generalization programming may result in the inability of the child to use PECS in their natural environment after the completion of the intervention.

Variation in the approaches used to program for generalization may lead to variation in child PECS outcomes. Effective generalization across settings, as reported by Dogoe et al. (2010) and Koudys et al. (2021), may be attributed to the creation of PECS teaching opportunities across multiple settings and the simultaneous use of MET. In contrast, of the studies that did not incorporate generalization strategies, one described effective generalization across setting results (i.e., Greenberg et al., 2012), compared to most others that observed that PECS use did not generalize across settings (e.g., Carre et al., 2009; Jurgens et al., 2012; Yoon, 2017). Yoon (2017) suggests generalization from the family's kitchen to free play in the living room and kindergarten classroom did not occur because the child was always prompted, had free access to items in the home and school, and PECS training only commenced in one setting (i.e., family kitchen). Similarly, children in other studies (e.g., Carre et al., 2009; Jurgens et al., 2012) rarely used PECS during free play in the generalization settings. This may be due to free access to items and activities in these settings. It is possible that the variability in the literature related to

PECS skill generalization may be the result of insufficient planning or teaching and may provide support for the need to plan for PECS generalization to ensure children display PECS skills in their natural environment across settings and stimuli. Although MET has been reported as beneficial to facilitate generalization in the literature (e.g., Dogoe et al., 2010; Koudys et al., 2021), it is still unclear how to best train for generalization (i.e., which settings/stimuli, how many settings/stimuli, how to arrange the environment).

Equally important to PECS skill generalization is the maintenance of PECS use overtime. Behaviour maintenance is defined by how long a new behaviour persists once the intervention is completely removed (Cooper et al., 2020; Pennington, 2019). Currently, there is more research that explores the short-term effects of PECS compared to research that explores long-term PECS outcomes (Jurgens et al., 2012). Studies may not conduct or report on long-term maintenance because implementation may be too expensive, time consuming, or viewed as insufficiently effective (Baer, 1989). These factors can all result in the loss of improvements that were evident throughout the implementation period (Baer, 1989). Several studies report on PECS skill maintenance (e.g., Bondy & Frost, 1994; Cannella-Malone et al., 2010; Charlop-Christy et al., 2002; Greenberg et al., 2012; Howlin et al., 2007; Jurgens et al., 2019; Odluyurt et al., 2016; Park et al., 2011), whereas others do not (e.g., Carre et al., 2009; Cummings et al., 2012; Dogoe et al., 2010; Koudys et al., 2021; Lerna et al., 2012). Of the studies that report on maintenance, there is variability in outcomes. Some studies report that PECS skills maintain for up to 1 week (e.g., Park et al., 2011), 2 weeks (e.g., Odluyurt et al., 2016), 1 month (e.g., Alsayedhassan et al., 2020; Park et al., 2011), 1 year (e.g., Charlop-Christy et al., 2002), and 18 months (e.g., Greenberg et al., 2012). Other studies report that PECS skills do not maintain over a 10-month (e.g., Jurgens et al., 2019) and 3-to-4-year period (e.g., Howlin et al., 2007).

In the literature, numerous methods of facilitating maintenance have been recommended. First, training natural communicative partners may support child PECS use over time. Several studies (e.g., Alsayedhassan et al., 2020; Park et al., 2011, Treszl et al., 2021) have trained caregivers to implement PECS with their child as a method to facilitate maintenance. In contrast, other studies solely taught PECS using a research assistant/therapist as the communicative partner (e.g., Carre et al., 2009; Cummings et al., 2012; Greenberg et al., 2012; Howlin et al., 2007). Further, teaching in environments that PECS is likely to be used in (i.e., home, community), with naturally occurring reinforcers may promote skill maintenance (Jurgens et al., 2019). Some studies (e.g., Jurgens et al., 2019; Park et al., 2011) taught PECS in the home with common preferred items. Others (e.g., Charlop-Christy et al., 2002) taught in multiple settings (e.g., therapy room, school, home) using preferred items that were common in each of the settings. In comparison, additional studies solely taught in a school/therapy-based setting (e.g., Greenberg et al., 2012; Howlin et al., 2007; Odluyurt et al., 2016) using preferred items. As previously noted, although some studies specifically program for maintenance by using natural communicative partners and teaching in natural environments, with naturally occurring reinforcers, others do not (e.g., Greenberg et al., 2012; Howlin et al., 2007; Odluyurt et al., 2016). If skill maintenance is not specifically programmed for, the skills learned during intervention may not maintain when the intervention is withdrawn (Baer, 1989).

The maintenance of PECS skills over time may be attributed to numerous factors. Several studies may have demonstrated the maintenance of PECS skills because the natural communicative partner (i.e., mothers) implemented PECS with high levels of integrity in all phases (e.g., Alsayedhassan et al., 2020; Park et al., 2011). Maintenance in other studies (e.g., Charlop-Christy et al., 2002) may be attributed to teaching across natural environments.

Additional studies do not report using specific maintenance strategies and fail to report why children maintained their skills (e.g., Greenberg et al., 2012; Odluyurt et al., 2016). For those studies that fail to use maintenance strategies and fail to demonstrate positive maintenance results, the cause may be attributed to numerous factors. First, Jurgens et al. (2019) attributed a lack of maintenance to contextual variables in the participant's home. For example, in the home, the participant had free access to all items, learned to move furniture to get out of reach items, and the mother reported that she anticipated what the participant wanted and provided access to that item to avoid problem behaviour. In addition, Howlin et al. (2007) did not incorporate natural communicative partners, nor did they teach in natural environments, which may have contributed to a lack of skill maintenance. Given the importance of communication skills, it is essential that PECS improvements maintain over time in natural environments (Jurgens et al., 2019). The variability of child PECS maintenance is concerning and speaks to the need for additional research in this area.

Ideally, PECS training would be designed to be both efficient and effective to optimize the use of limited resources; fortunately, there is evidence that children can make and maintain progress following a brief intervention. Charlop-Christy et al. (2002) implemented a multiple baseline across participants design to teach three children between the ages of 3 and 12 how to communicate using PECS. Sessions were conducted in a training room, empty classrooms, and children's homes to promote the generalization of PECS skills to the natural environment after the completion of the study. Sessions were 15 mins and were conducted 2 days per week. Therapists implemented PECS using the techniques outlined by Bondy and Frost (1994). Results suggest that the participants reached mastery criterion for the six PECS phases within an average of 170 mins of training. The participant who was available for 1 year maintenance assessments

continued to initiate and request using PECS at a substantially higher level than baseline (i.e., 52 requests per session during maintenance assessments compared to 11 during baseline). In addition, the researchers identified improvements in social-communicative behaviours and decreases in problem behaviours. The fast acquisition and maintenance of PECS skills over time is particularly noteworthy; however, there were multiple limitations. First, although the researchers trained across numerous settings to facilitate generalization, data were not directly collected on generalization. In addition, the mastery criterion for each phase of PECS was 80% correct responding across one 10-trial block. Since this criterion did not include any generalization factors across settings, stimuli, or individuals, the authors may have reported faster skill acquisition and higher PECS accuracy. Therefore, children may have progressed more rapidly than in other studies and they may not have been as proficient in using PECS in generalized conditions.

In addition to intervention efficiency, training in a manner that facilitates PECS use across settings and within natural environments should also be prioritized. One study where caregivers reported that PECS use generalized to the home was conducted by Koudys et al. (2021). In this community study, a pre-post group design was used to teach PECS to 22 children between the ages of 2- and 18-years at a summer camp in local churches and common community settings (e.g., parks, pools). Children participated in camp 6 hrs per day, and 5 days per week. The average number of days children attended camp was 28. Camp workers who implemented PECS teaching received one day of PECS training, as well as individual coaching on their assigned camper's PECS program. Training and coaching were provided by a consultant with Pyramid Educational Consultants of Canada (the creators of PECS). Multiple exemplar training was implemented to increase generalization to untrained stimuli and settings. Camp

workers created communication opportunities in different settings (e.g., playroom, park), different activities (e.g., swimming, snack), and used a diversity of reinforcers (e.g., edibles, toys). Results highlighted significant improvements in PECS communication skills (phases 1 to 4), the ability to generalize requests to different reinforcers, activities, and environments, as well as a reduction in problem behaviour. However, this study was not without limitations. Although caregivers reported that PECS use generalized to the home, data on PECS generalization was not directly assessed. In addition, maintenance data were not collected once the camp was completed.

Overall, the literature related to child PECS teaching indicates that it is effective; however, there is variability in the approaches used to facilitate generalization and maintenance, and variability in outcomes. Gaps in the literature make it difficult to determine how best to efficiently and effectively teach children to use PECS in a manner that supports generalized, maintained PECS use.

PECS Caregiver Training

Caregivers play a crucial role in the development of their child's social and communication skills. Therefore, teaching caregivers to implement PECS may enhance children's communication skills in the natural environment without the extra cost of therapy sessions (Park et al., 2011). Further, without the creation of communication opportunities in the natural environment, communication skills may not be maintained (Moorcroft et al., 2019). To support the long-term use and maintenance of PECS skills in the natural environment, it is important to involve caregivers. Fortunately, following caregiver PECS training, many studies report positive caregiver teaching outcomes (e.g., Alsayedhassan et al., 2020; Carson et al., 2012; Chaabane et al., 2009; Greenberg et al., 2012; Jurgens et al., 2012; Park et al., 2011; Stiebel,

1999; Treszl et al., 2021). These results are derived from single case research designs, including changing criterion designs (e.g., Alsayedhassan et al., 2020; Carson et al., 2012; Park et al., 2011), multiple baseline across behaviour designs (e.g., Chaabane et al., 2009; Stiebel, 1999; Treszl et al., 2021), and multiple baseline across participant designs (Alsayedhassan et al., 2020; Greenberg et al., 2012). Within these research studies, some authors report using the PECS manual created by Bondy and Frost (1994) to guide caregiver teaching practices (e.g., Alsayedhassan et al., 2020; Greenberg et al., 2012; Park et al., 2011; Treszl et al., 2021). The training manual (Frost & Bondy, 2002) describes the teaching procedures for each PECS phase. Similar to how each phase involves a unique target behaviour (e.g., phase 1 teaches the picture exchange, phase 2 teaches distance and persistence), each phase also involves a unique set of teaching strategies to facilitate PECS users' skill development. Although the teaching strategies are all derived from behaviour analysis (e.g., prompting, fading, reinforcement), the application and combination of these strategies varies across phases. For example, backwards chaining, prompting, fading, and reinforcement are used in phase 1, compared to shaping and reinforcement in phase 2, and reinforcement, extinction, and prompting in phases 3a and 3b. The general components of teaching a PECS exchange are setting up the communication opportunity, responding to a correct exchange, and responding to an incorrect exchange. Within each of these components, basic behaviour analytic concepts and principles are involved. For example, an establishing operation can be manipulated when setting up the communication opportunity to increase the value of a reinforcer. Responding to a correct exchange incorporates the principle of reinforcement and responding to an incorrect exchange uses the principles of punishment/extinction. Prompting and fading are techniques implemented throughout training as

part of establishing stimulus control. The specific teaching approaches required for each phase are described in Appendix B.

Although the authors of the training manual outline specific teaching strategies to use for each phase, and highlight the importance of engaging natural communicative partners, they do not specify how best to train these individuals. Details such as the training model, length of training sessions, number of sessions and/or trials, and trainer qualifications are not described. Perhaps as a result, there is variability in the general approach to caregiver PECS training in the literature. For example, although many studies (e.g., Alsayedhassan et al., 2020; Chaabane et al., 2009; Park et al., 2011; Treszl et al., 2021) trained caregivers using behavioural skills training (BST; instructions, modelling, rehearsal, feedback; Miltenberger, 2008), some trained using only modelling and feedback (e.g., Carson et al., 2012), discussion and feedback (e.g., Stiebel, 1999), or the method of training was unclear (e.g., Greenberg et al., 2012; Jurgens et al., 2012). Further, the lengths of caregiver training sessions are rarely reported in the literature. Of those studies that do report these details, several reported that they trained caregivers for 40 to 60 mins per phase (Park et al., 2011) or 45 to 60 mins per session (Treszl et al., 2021). However, other studies do not report on the length of training (e.g., Alsayedhassan et al., 2020; Chaabane et al., 2009; Greenberg et al., 2012; Jurgens et al., 2012). In addition, Treszl et al. (2021) describe that 24 trials were conducted in each training session; however, no other studies describe the number of training sessions or the number of trials (e.g., Alsayedhassan et al., 2020; Chaabane et al., 2009; Greenberg et al., 2012; Jurgens et al., 2012; Park et al., 2011).

Similar gaps in the literature are found regarding treatment integrity, defined as the accurate execution of an intervention (Cooper et al., 2020). Treatment integrity is important because if the intervention is not implemented as per the procedures, it is difficult to determine if

lack of skill improvement is due to a poorly selected intervention or inaccurate treatment implementation (Cooper et al., 2020). In the literature, caregiver PECS treatment integrity is not always reported (e.g., Carson et al., 2012; Greenberg et al., 2012). Of those that do report on caregiver treatment integrity, most studies suggest caregivers achieved >90% integrity (e.g., Alsayedhassan et al., 2020; Chaabane et al., 2009; Park et al., 2011; Stiebel, 1999; Treszl et al., 2021). In contrast, one study reviewed YouTube videos for errors and discovered 43% of videos and 61% of PECS exchanges consisted of caregiver implementation errors (Jurgens et al., 2012). The cause of low levels of treatment integrity in these videos is uncertain as it is unclear whether caregivers had access to training, and if so the nature of training that was provided. However, it is plausible that the results may be attributed to a lack of—or poor—caregiver training.

In addition to selecting effective training approaches and training to an adequate level of treatment integrity, it is also important to have a well-qualified trainer to teach caregivers to implement PECS. In the literature, there is variability in PECS trainer qualifications. For example, some studies state simply that the trainer was proficient in PECS (e.g., Park et al., 2011). Others describe the trainers' educational backgrounds (e.g., a doctoral and graduate student; Alsayedhassan et al., 2020) or PECS experience (e.g., trained in PECS Level One or Two and had between 3.5 and 15 years of clinical experience; Treszl et al., 2021). Additional studies do not specifically describe trainer qualifications (e.g., Chaabane et al., 2009; Greenberg et al., 2012; Jurgens et al., 2012). Overall, the variability in the general approach to training caregivers to implement PECS (i.e., type of training model, length of training sessions, level of treatment integrity, number of sessions and/or trials, trainer qualifications) makes it difficult to determine how best to train caregivers in an effective and efficient manner.

Equally important to establishing an effective and efficient caregiver training model is determining a model that facilitates PECS implementation in natural environments over time. Many studies solely report on child PECS maintenance and generalization; however, do not report on the maintenance and generalization of caregiver PECS teaching skills (e.g., Carre et al., 2009; Dogoe et al., 2012; Greenberg et al., 2012; Jurgens et al., 2012; Koudys et al., 2021; Yoon, 2017). Of the studies that investigate caregiver PECS teaching skills (e.g., Alsayedhassan et al., 2020; Carson et al., 2012; Chaabane et al., 2009; Greenberg et al., 2012; Jurgens et al., 2012; Park et al., 2011; Stiebel, 1999; Treszl et al., 2021), Treszl et al. (2021) is the only study that systematically explores caregiver PECS maintenance and generalization. In this study, strategies to help a 35-year-old mother and 39-year-old father implement PECS with their child at home were investigated. An online virtual platform was used to teach the father to implement PECS through BST and general case training (GCT; described below), whereas the mother acted as the confederate. Although the mother did not receive the full BST package, she listened to the instructions and observed the live and video models, and data were collected on her performance. The researchers who taught the caregivers were both trained in PECS Level One or Two and had between 3.5 and 15 years of clinical experience. Results suggest that the caregiver trainee was able to implement all taught PECS skills in the training setting with a high degree of integrity and maintained his skills over 6 weeks. In addition, the trainee implemented skill one (i.e., setting up communication opportunities) and skill two (i.e., conducting a correspondence check) with high integrity in the natural environment; however, he did not reliably generalize skill three (i.e., error correction) to the natural environment. The authors suggest this may be attributed to the lack of practice opportunities of skill three in the training and natural environment as training was completed after the mastery of skill three. In addition, the mother who roleplayed the

confederate received lower treatment integrity scores for skills two and three in the generalization and maintenance assessments. This may be attributed to the fact that she did not practice the different skills or receive performance feedback. Rather she only received the written instructions and observed the PECS video and live models. The results of this study are particularly noteworthy as they provide preliminary evidence of the benefits of using BST plus GCT to train caregivers to implement PECS with their children in the natural environment. However, this study was not without limitations. The study only implemented the training with one caregiver, examined only one phase of PECS (i.e, phase 3b), and the child was already communicating with PECS prior to the start of the study.

GCT Mediator Training

Exposing caregivers to different scenarios they may encounter when teaching PECS to their child may help to support them in generalizing their skills to the natural environment. One method of teaching, GCT, encourages generalization by including multiple exemplars that sample all possible stimulus and response variations in a desired situation (Sprague & Horner, 1984). This is termed the *instructional universe* and research demonstrates that programming in a manner that specifically incorporates the instructional universe is effective in supporting generalized behaviour change (Horner & McDonald, 1982). As opposed to other generalization approaches—that may choose stimulus and response variations in an unsystematic manner—GCT involves several structured steps that result in the systematic identification and incorporation of stimuli and responses (Sprague & Horner, 1984). Horner et al. (2005) defined these steps as: (a) defining the instructional universe (i.e., the entire range of required stimulus and response variations), (b) creating teaching examples that incorporate the whole range of stimulus and response variations in the instructional universe, (c) sequencing the teaching

examples to help the learner discriminate, (d) teaching the examples, and (e) testing with novel probe examples.

Sprague and Horner (1984) published one of the first studies on GCT and investigated how high school students diagnosed with intellectual disabilities could learn how to use a variety of vending machines. The authors conducted a general case analysis by outlining the five necessary responses for correct vending machine operation, specifying the discriminative stimulus that should control each response, specifying any variations in the discriminative stimulus across machines, specifying any variations in the five responses, and selecting a sample of examples that represented the complete range of stimulus and response variations for each discriminative stimulus and required response for vending machine usage. They then compared participant outcomes following single instance training (i.e., training with a single teaching example), multiple instance training (i.e., training with multiple teaching examples), and GCT. The researchers found that it was only after implementation of GCT that the participants could generalize their skills and perform all steps required to purchase an item across all vending machines.

In the literature, BST has been combined with GCT to teach mediators to implement independent self-care routines to clients (e.g., Ducharme & Feldman, 1992), feeding interventions (e.g., Alaimo et al., 2018), PECS (e.g., Treszl et al., 2021), discrete trial training (DTT; involves using a discriminative stimulus, structured prompts, a desired behaviour, and reinforcement; e.g., Lerman et al., 2016; Ward-Horner & Sturmey, 2008), and natural language paradigm (NLP; a flexible approach to DTT for improving verbal behaviour that involves modelling, imitation, and reinforcement; e.g., Koegel et al., 1987; Seiverling et al., 2010). Participants in these studies included staff (e.g., Ducharme & Feldman, 1992; Seiverling et al.,

2010) and caregivers (e.g., Alaimo et al., 2017; Treszl et al., 2021; Ward-Horner & Sturmey, 2008). The researchers who trained staff and caregivers used multiple baseline across participant designs (e.g., Alaimo et al., 2017; Ducharme & Feldman, 1992; Seiverling et al., 2010; Ward-Horner & Sturmey, 2008) and multiple baseline across behaviour designs (e.g., Treszl et al., 2021). Further, training using BST plus GCT resulted in high treatment integrity post intervention (e.g., Alaimo et al., 2018; Ducharme & Feldman, 1992; Seiverling et al., 2010; Treszl et al., 2021; Ward-Horner & Sturmey, 2008), maintenance after the removal of the intervention (e.g., Alaimo et al., 2018; Treszl et al., 2021; Ducharme & Feldman, 1992; Seiverling et al., 2010), and generalization to additional exemplars (i.e., exemplars not used in training; e.g., Ducharme & Feldman, 1992; Ward-Horner & Sturmey, 2008), children (e.g., Seiverling et al., 2010), and settings (e.g., Treszl et al., 2021). Unfortunately, some studies (e.g., Alaimo et al., 2018) do not present caregiver generalization data. This is a substantial limitation as the purpose of GCT is to facilitate generalization, and therefore, a lack of caregiver generalization data makes it difficult to evaluate the benefits of the training. As previously noted, one study used BST plus GCT to train caregivers to teach their autistic child to use PECS and results suggest that the caregiver generalized some skills to the natural environment (Treszl et al., 2021).

Gaps in PECS Research

PECS is considered an evidence-based intervention for children with ASD (Hume et al., 2021; Sam & AFRIM Team, 2016). Although PECS is a manualized intervention, with well-defined teaching strategies, there is significant variability in the general approaches that are used to teach PECS (i.e., length of teaching, ideal number of sessions and/or trials per session, duration of intervention) and it is unclear how to best balance teaching efficiency and

effectiveness. In addition, the results from research related to the generalization and maintenance of PECS skills are also variable.

Further, research results indicate that caregiver training is effective in teaching caregivers to implement PECS with their children and subsequently children have made progress following caregiver-mediated PECS teaching (e.g., Alsayedhassan et al., 2020; Chaabane et al., 2009; Park et al., 2011). However, a considerable amount of variability is found in the general approaches used to train caregivers (i.e., type of training model, length of training sessions, level of treatment integrity, number of sessions and/or trials, trainer qualifications). As such, it is difficult to identify an approach to training that is both efficient and effective. In addition, only one study (i.e., Treszl et al., 2021) reported on caregiver skill generalization and maintenance. Therefore, our understanding of the social validity of caregiver training, as indicated by the generality and maintenance of the results, is limited. Although Treszl et al. (2021) made an important contribution to the related literature, to date theirs is the only published study that combines GCT and BST to teach caregivers how to implement PECS—and as previously noted, this study involved only one family, taught only one phase of PECS, and only some skills generalized to the natural environment. As resources are scarce, it is critical to determine an efficient PECS teaching model that is effective, easily accessible to autistic children and their caregivers, and facilitates generalized and maintained PECS skills once the intervention is complete.

Given the identified gaps in the literature, the purpose of the present study was to explore the impact of a brief combined caregiver and child 1-week PECS camp on child PECS outcomes and caregiver PECS implementation, and to report on caregiver and child skill generalization and maintenance. The present study extended the results of Koudys et al. (2021) and Dogoe et al. (2012), by using MET and teaching PECS across more locations (e.g., therapy room,

playground, snack room, gym), using different categories of stimuli (e.g., edibles, small/large toys, stationary/movable items) to promote child PECS generalization. Skill maintenance was supported by teaching natural communicative partners (i.e., caregivers) to implement PECS with their child, as well encouraging caregivers to create communication opportunities throughout the day in different settings and with different naturally reinforcing stimuli. In addition, the present study extended the research of Treszl et al. (2021) by implementing the PECSperts Caregiver Training Package (i.e., a structured training package designed to teach caregivers to implement PECS with their child) with a larger number of caregivers and with children who had not previously used PECS. The present study also taught additional phases of PECS (i.e., four phases compared to one), and assessed a longer maintenance period (i.e., 12 weeks compared to 6).

Research Questions

1. What are child outcomes, as evidenced by average child PECS accuracy, following one week of PECS teaching in a camp setting? Does child PECS use generalize to the home setting and maintain over time?
2. What are caregiver outcomes, as evidenced by average caregiver PECS treatment integrity, following the PECSperts Caregiver Training Package in a camp setting? Do caregiver PECS teaching skills generalize to the home setting and maintain over time?
3. Do caregivers find PECS, the brief camp format, and the PECSperts Caregiver Training Package acceptable and effective?

Methods

Participants

Ten caregiver-child dyads were recruited through local community agencies (e.g., Bethesda, Niagara Children's Centre), caregiver support networks (e.g., Autism Ontario, Ontario

Autism Coalition), and social media (e.g., Twitter, Facebook). All caregivers (one from each participating family) provided consent for themselves and their child to participate in the study. Two caregiver-child dyads withdrew from the study at the beginning of the camp; one dyad was unwell and the other encountered transportation difficulties. Eight caregiver-child dyads completed the camp.

The eight children were an average age of 3 years, 6 months (range 2 years, 5 months–5 years, 1 month). Details of child participants' cognitive skills, adaptive level, and autism symptom severity are described in Table 1. Results of psychological assessments indicate that all children had significant delays in cognitive and adaptive functioning, and moderate to severe autism symptomatology. All caregivers reported their child had a diagnosis of ASD, significant communication deficits (i.e., caregivers reported child using fewer than 20 words functionally), did not have an established AAC system, and did not engage in significant problem behaviour (e.g., self-injurious behaviour, tantrums, aggression).

The eight caregivers in the study were an average age of 33 years old (range 28–39). Caregivers' ethnicities were Caucasian (n = 5), Afro-Canadian (n = 1), Croatian (n = 1), and Asian (n = 1). All caregivers spoke English as their first language except for one who spoke Tibetan. In addition, one caregiver spoke English and Hindi as their second language, and one spoke Croatian. All other caregivers did not speak a second language. Caregivers' highest level of education was high school (n = 1), college (n = 6), and university (n = 1). Six caregivers were married, one was common law, and one was divorced. All caregivers were able to communicate in English and understand spoken and written instructions in English. No caregivers had ever received formal PECS training (e.g., official workshops, PECS modules, PECS coaching).

Table 1

Child Participants' Characteristics

Psychological Measures					
Participants	Autism Symptom Severity (CARS2 Total)	Adaptive Behavior Composite (Standard Score)	Developmental Level (Ratio IQ)	Overall Mental Age (Months)	Chronological Age (Months)
P1	28.5	68	43	15.0	35
P2	40.0	61	22	10.5	46
P3	32.5	66	54	21.0	39
P4	39.0	66	31	15.5	50
P5	34.5	56	21	10.5	49
P6	32.0	78	50	15.0	30
P7	42.0	57	24	15.0	62
P8	43.5	N/A	22	8.5	38
<i>M</i>	36.5	64.6	33.4	13.9	43.6
<i>SD</i>	5.4	7.5	13.6	3.9	10.2
Range	28.5–43.5	56–78	21–54	8.5–21.0	30–62

Notes. Participants were assessed at T1. Autism symptom severity assessed by the Childhood

Autism Rating Scale, Second Edition, Standard Form (CARS2-ST; Schopler et al., 2010).

Adaptive behaviour assessed by the Vineland Adaptive Behavior Scales, Third Edition (Sparrow et al., 2016). Developmental level and mental age determined using the Mullen Scales of Early Learning (MSEL; Mullen, 1995); scores presented as ratio IQ and median mental age.

Setting and Materials

The summer camp took place in Thorold, Ontario at a community agency that provides respite services, Ontario Autism Program services, children’s developmental assessment services, and general behaviour services for people with intellectual and developmental disabilities, as well as related communication disorders. The 1-week PECS camp child teaching sessions took place in various areas of a building dedicated to children’s services, including the outdoor play area, playground, gym, kitchen, sensory room, and various activity and therapy rooms. Caregivers received training on site in a designated training room that was equipped with adult size tables and chairs, a screen (for sharing slides during the training session), and various

training resources. Caregivers moved to other locations on site (as described above) to engage in coaching sessions with their child. Assessment activities took place in small therapy rooms at the Brock University Applied Disability Studies clinic. These rooms were set up in a manner similar to therapy rooms at the camp (i.e., each room had a child-sized table and chairs, and a variety of children's toys, such as blocks, books, figures).

Each family received a 260mm by 235mm, three-ring, standard PECS binder. The binder was made from a thick, poly plastic, durable material and was equipped with hook fasteners, two non-tabbed insert pages, and one appropriately sized sentence strip. Laminated pictures (printed icons or photographs) were 45mm by 45mm in size and corresponded to the array of practice materials and an assortment of commonly used toys, activities, and food/drink (i.e., putative reinforcers). Each caregiver also received a PECS 2nd Edition manual (Frost & Bondy, 2002). Additional materials included items that were relevant to different settings and activities, such as playground and gym equipment, food and drink in the kitchen/snack area, or toys related to the sand/water table, crafts, etc. Pictures that corresponded to these items and activities were available in each room during communication training.

Camp Mediators and Caregiver Trainers

Camp mediators (mediators) were a combination of community professionals (e.g., staff at the community agency) and graduate students (i.e., Brock University Applied Disability Studies [ADS] graduate students specializing in ABA, York University graduate students in clinical psychology). All mediators had a minimum of one year experience implementing ABA programs (supervised by a Board Certified Behavior Analyst[®]; BCBA[®] or Board Certified Behavior Analyst-Doctoral[®]; BCBA-D[®]) and experience implementing PECS with people who have communication deficits. Mediators attended the official 13 hr 2-day PECS Level One

training offered by Pyramid Education Consultants of Canada and participated in an additional 2-day (i.e., 14 hr) BST that taught them how to implement PECS within the camp setting. A BCBA and a BCBA-D with expertise implementing and supervising PECS conducted the training, assessed the mediator's PECS implementation skills, and supervised implementation over the study. Mediators achieved an average of 97% (range 92%–100%) procedural fidelity on phase 1, 97% (range 89%–100%) on phase 2, 96% (range 91%–100%) on phase 3a, and 97% (range 93%–100%) on phase 3b prior to implementing PECS with participants. Mediators also received training on PECS data collection and practiced coding videos of prior PECSpert study participants (with caregiver consent). Mediators scored child performance on each phase of PECS and achieved an average interobserver agreement (IOA) of 100% on phase 1, 90% (range 80%–100%) on phase 2, 100% on phase 3a, and 98% (range 80%–100%) on phase 3b.

The lead caregiver trainer was a BCBA with extensive experience implementing PECS (≥ 15 years). This trainer attended both the official 2-day PECS Level One and Level Two trainings offered by Pyramid Education Consultants of Canada. She also participated as a co-investigator in two prior research studies using the PECSperts Caregiver Training Package. During these studies, she received direct supervision and consultation from Pyramid Educational Consultants of Canada. She has used evidence-based approaches to train mediators and caregivers to implement PECS in both research studies as well as clinical practice. The lead caregiver trainer was supported by assistant caregiver trainers who also attended the official 2-day PECS Level One training and had over 5 years' experience implementing PECS. The assistant caregiver trainers participated in prior PECS research studies during which they either facilitated or completed 2 days of BST to learn to implement PECS and train caregivers to implement PECS. Further, the assistant caregiver trainers had extensive experience coaching

caregivers using BST and conducting PECS caregiver integrity checks. All project activities, including child PECS teaching and caregiver training, were overseen by the Principal Investigator who is a BCBA-D and Registered Clinical Psychologist, the former Director of Pyramid Educational Consultants of Canada, and has >15 years of experience training, supervising, and implementing PECS with individuals with communication disorders. This includes extensive experience delivering the official 2-day PECS Level One and Level Two trainings offered by Pyramid Education Consultants of Canada.

Measures

Mullen Scales of Early Learning (MSEL)

The MSEL (Mullen, 1995) measures cognitive/developmental functioning in children from birth to 5 years, 8 months. A full administration of the MSEL results in a composite score and subscores in the specific areas of Expressive and Receptive Language, Visual Reception, and Fine and Gross Motor skills. Mullen (1995) reported that the MSEL test displays both internal and test-retest reliability. An Overall Mental Age score was determined for each participant using the median of four subscales (i.e., Receptive Language, Expressive Language, Visual Reception, Fine Motor). This median score was then used to calculate a Ratio IQ ($\text{Mental Age [MA]} / \text{Chronological Age [CA]} \times 100$) for each participant. Scores of 69 and below are often associated with intellectual disability, scores between 70 to 79 are considered borderline, and scores between 80 to 119 are within the average range.

Vineland Adaptive Behavior Scales, Third Edition (Vineland-3).

Sparrow et al. (2016) developed the Vineland-3, Parent/Caregiver Rating Form to assess adaptive and maladaptive behaviour in individuals ranging from birth to 90 years old. The Vineland-3 is commonly used to inform diagnoses of intellectual/developmental disabilities.

Skills and behaviours are assessed in the following domains: Daily Living Skills, Socialization, Communication, and Motor Skills for children younger than 6 years old. Further, the Vineland-3 has strong indicators of validity and internal consistency (Pepperdine et al., 2017). An Adaptive Behavior Composite score was derived from the Daily Living Skills, Socialization, and Communication domains and presented as a standard score. Standard scores between 20 to 70 indicate a low adaptive level, 71 to 85 indicate a moderately low adaptive level, and 86 to 114 indicate an adequate adaptive level. An increase in scores is positively correlated with an increase in adaptive level.

Childhood Autism Rating Scale, Second Edition, Standard Form (CARS2-ST)

The CARS2-ST (Schopler et al., 2010) was used to measure autism symptom severity. The CARS2-ST is a clinical rating scale that relies on the direct observation of the child. An observer rates 15 specific categories in the CARS2-ST using a 7-point scale (1–4 with half points). Scores from each category are added together to calculate the total score. Scores below 30 indicate the absence of autism while scores of 30 or above indicate the presence of autism. Higher scores indicate greater autism symptom severity. Scores between 30 to 36.5 indicate mild/moderate autism and 37 or greater, severe autism. Reports of the original CARS indicate excellent reliability and validity (Perry et al., 2005).

Caregiver Demographic Form (Appendix C).

The *Caregiver Demographic Form* consisted of 11 questions related to caregivers' demographic information, including age, ethnicity, first language, other languages spoken, marital status, highest level of education, degree/diploma type, workplace, specific role at work, and whether employment was part-time, full-time, or casual.

Caregiver Treatment Integrity Checklist (Appendix D).

Caregiver PECS treatment integrity and child PECS accuracy were assessed using the *Caregiver Treatment Integrity Checklist*. The checklist had 15 items in phase 1, 13 in phase 2, 19 in phase 3a, and 18 in phase 3b. The items in the checklist for each phase of PECS involved setting up the environment, responding to a correct exchange, and responding to an incorrect exchange. Each checklist item had a specific operational definition. The checklist also included space to score child performance. The checklist, and caregiver and child scoring criteria, were based on the PECS protocol created by Bondy and Frost (2002) and were designed in collaboration with Pyramid Educational Consultants of Canada. In addition, the checklist was a revised and expanded version of the one used by Treszl et al. (2021).

Social Validity Questionnaire (Appendix E)

Each caregiver completed a social validity questionnaire. The questionnaire was an adapted version of the Treatment Acceptability Rating Form (TARF-R; Reimers & Wacker, 1988) and was used to assess the effectiveness and acceptability of the training program from the caregiver's perspective. The first set of questions focused on the caregiver's experience learning to teach PECS. These questions were rated on a 5-point Likert-scale (i.e., 1 = *not at all clear, not well, not at all acceptable*, and 5 = *very clear, very well, very acceptable*). The second set of questions focused on the caregiver's experience teaching their child PECS using a similar 5-point Likert-scale (e.g., 1 = *not at all acceptable, not at all willing, not at all reasonable, unlikely, not at all confident*, and 5 = *very acceptable, very willing, very reasonable, very likely, very confident*). Multiple questions were reverse scored (i.e., 1 = *not at all likely, no side effects, no discomfort at all*, and 5 = *many are likely, many side effects, very much discomfort*). Two open-ended questions asked caregivers to identify the most helpful or most preferred aspects of the PECS camp, and least helpful or least preferred aspects.

Research Design

This study implemented a pre-post group design (Bonate, 2000) with caregiver PECS treatment integrity and child PECS accuracy assessed in two locations: (a) camp-clinic (i.e., training setting) and (b) family home (i.e., generalization setting) at four time points. Time 1 (T1) was the pre-assessment before the start of camp. Time 2 (T2) occurred immediately after camp was completed (i.e., within 1 week). Maintenance data were collected at Time 3 (T3; 1 month after the completion of camp) and Time 4 (T4; 3 months after the completion of camp). Although this was not an experimental design, given the wealth of research supporting PECS as an evidence-based practice, the intent was not to evaluate the efficacy of PECS. Rather the purpose was to (a) explore caregiver and child outcomes following a brief, combined caregiver and child 1-week PECS camp, and (b) report on caregiver and child PECS skill generalization and maintenance. Despite the threats to internal validity (e.g., history effects, maturation effect, Hawthorne effect), given the objectives of this research, and the community-engaged nature of the project, this was an appropriate research design (Cranmer, 2017). Ethical approval for this research was obtained through the university Research Ethics Board and the community agency.

Dependent Variables

Caregiver PECS Treatment Integrity

The first dependent variable was caregivers' accuracy of PECS implementation (i.e., treatment integrity) in the camp-clinic and home settings at the four timepoints. Caregiver treatment integrity was defined as the percentage of correct PECS implementation steps per PECS phase. All caregiver-child PECS assessments were videotaped, and trained observers collected data from video. Specifically, trained observers collected data on caregiver treatment integrity using the *Caregiver Treatment Integrity Checklist* while caregivers implemented PECS

phases 1 to 3b with their child. Five trials were conducted for each PECS phase. A trial began when the trained observer vocally stated the phase and trial number (e.g., “You can now start phase 2 trial 1”) and terminated when the trained observer vocally stated the trial number was complete (e.g., “Trial 1 is done”). In each trial, a correct response was scored with a “+” for each item accurately performed by the caregiver without any assistance/support. An incorrect response was scored with a “-” for each item inaccurately performed by the caregiver or if the caregiver omitted a specific item. An item was scored “NA” if the caregiver was not required to perform an item on the checklist. Once the caregiver finished a trial, the number of items performed correctly were divided by the total number of correct plus incorrect items and multiplied by 100. Responses marked as “NA” were not included in the total number of items per phase. The overall percentage of correct responding was calculated for each phase of PECS at all four time points in the camp-clinic and home settings by determining the average of caregivers’ treatment integrity across all five trials, for each PECS phase.

Child PECS Accuracy

The second dependent variable was child PECS accuracy in the camp-clinic and home settings at the four timepoints. Child PECS accuracy was defined as the percentage of correct picture exchanges at each PECS phase. As stated above, all caregiver-child PECS assessments were videotaped, and data were collected from video. Trained observers collected data on child behaviour using the child portion of the *Caregiver Treatment Integrity Checklist* during the implementation of PECS by caregivers (i.e., five trials per PECS phase, as described above). A trial consisted of the same start/termination criteria as caregiver trials. Appendix A illustrates the requirements of each PECS phase. In each trial, a response was considered correct and scored with a “+” if the child performed all aspects of the picture exchange at the specific phase with no

assistance. A response was considered incorrect and scored with a “-” if the child required prompting on any aspects of the picture exchange at the specific phase, as well as if the child did not complete the exchange and/or engaged in problem behaviour (e.g., flopping, destructive behaviour, aggression, etc.). Definitions for correct and incorrect child responses were generally based on the descriptions in the PECS Training Manual (Frost & Bondy, 2002). The overall percentage of child accuracy was calculated for each phase of PECS at all four time points in the camp-clinic and home settings by adding the number of correct responses together, dividing by the total number of trials per phase (i.e., 5), and multiplying by 100.

Independent Variables

PECSperts Caregiver Training Package

The PECSperts Caregiver Training Package was the first component of the 1-week PECS camp and included two parts: (a) caregiver training using BST plus GCT, and (b) caregiver-child coaching.

Caregiver Training. Part 1 of the structured PECSperts Caregiver Training Package involved caregiver training using BST plus GCT to teach caregivers phases 1 to 3b. The resources used in each phase included a caregiver handout, lesson plan, and phase overview and scenario videos. Caregiver handouts included the same steps as the *Caregiver Treatment Integrity Checklist* as well as a rationale for each phase. The lesson plans were comprised of scripts and specific instructions that the caregiver trainers followed when teaching each phase. The lesson plans were created to ensure each caregiver training session incorporated all four components of BST: (a) vocal and written instructions (in the form of caregiver handouts), (b) models (in the form of video models using GCT, described below) (c) roleplaying target behaviours, and (d) receiving positive and corrective feedback. For each PECS phase, an

overview video and scenario videos were created. The overview video for each phase consisted of a step-by-step model showing how to correctly set-up PECS trials, and how to respond to correct trials using reinforcement, and incorrect trials using error correction. The scenario videos were designed to highlight all possible situations that could occur (GCT; described below). The PECSperts Caregiver Training Package was created to teach a new phase of PECS each session or day.

To incorporate the GCT procedures into the scenario videos, the *instructional universe* created by Treszl et al. (2021) was expanded to include phases 1 to 3b. For each phase, Treszl et al. (2021) and Koudys et al. (in preparation) established the instructional universe by defining: (a) all possible caregiver responses required to teach each phase of PECS, (b) all target child behaviours for each phase of PECS, (c) all possible variations in child behaviour for each PECS phase (e.g., correct response, incorrect response, change in motivation,), (d) all possible variations of reinforcers (e.g., consumables—edibles, bubbles; non-consumables—toys, electronics; small items; large items; stationary items; movable items; activities—spin, swing, tickle, up), and (e) all possible variations in binder and picture variables based on the PECS phase (e.g., binder beside the child, binder across the room, picture on the front of the binder, picture inside the binder, picture missing). These scenario videos were approximately 1 to 2 mins in length and were designed using GCT procedures to expose caregivers to a variety of situations they may encounter when teaching their child to use PECS. An example of the instructional universe for phase 1 is depicted in Appendix F, and corresponding scenario list in Appendix G.

Caregiver-Child Coaching. Part 2 of the PECSperts Caregiver Training Package involved caregiver trainers providing direct coaching to support caregivers while they implemented the PECS phase of the day with their child. Caregiver-child coaching procedures

were modified from Gerow et al. (2021) and included the caregiver trainer: (a) speaking to the child's camp mediator about the child's progress during the day and providing useful information to the caregiver (i.e., child's reinforcers, effective prompts, activities to embed PECS trials in), (b) asking the caregiver if they were comfortable with the suggestions provided, (c) explaining the nature and sequence of activities that would occur during the coaching session to the caregiver (e.g., reminding the caregiver that phase 2 will be taught, their child seems interested in the slide, and that they will watch a few trials of the camp mediator and their child before being supported to conduct a few trials), (d) allowing the mediator to model several PECS trials at the target phase, (e) supporting the caregiver to implement the target PECS phase with their child, (f) providing in-the-moment prompting and support as needed (e.g., gesturing to caregiver's hand to remind them to open hand immediately during phase 1 trial), and (g) providing positive or corrective feedback in-the-moment and after the completion of each trial to help the caregiver correctly implement PECS with their child (e.g., verbal praise for delivering reinforcer within 1/2 s, verbal reminder to label item in the next trial). Caregiver trainers purposely attempted to provide caregiver-child coaching in different settings, activities, and with different reinforcers to further program for generalization.

Child Teaching Sessions

The second component of the 1-week PECS camp was child teaching sessions. Mediators set up each PECS trial using the phase-specific teaching strategies described in Appendix B and taught phases 1 to 3b as per the PECS Training Manual (Frost & Bondy, 2002). Mediators followed children's lead, supported PECS use only when children showed interest in an item/activity, delivered prompts in a manner designed to support children to meet their needs, and used strategies to promote a positive learning experience (e.g., offering a variety of

reinforcers, increasing time with reinforcers, not interfering with how children engaged with reinforcers, taking breaks, going for walks). A trial began when the mediator identified the child's interest (e.g., the child reached for or approached the item, or reached toward the picture) and was terminated when the child received the reinforcer (either following a correct or prompted exchange, or completion of error correction procedures). Correct responses, as well as trials that required prompting, resulted in access to the desired item/activity. Incorrect responses resulted in the use of error correction procedures specific to the phase of PECS, which also terminated in access to the desired item/activity (Appendix H). Mediators used MET and were encouraged to create teaching opportunities in a minimum of three camp activities (e.g., games, sand table, free play), across three different settings (e.g., playground, kitchen, therapy room), using reinforcers from three categories of reinforcers (e.g., edibles, toys, activities) per day.

Procedures

Intake

Caregiver participants initially completed the participant screening interview and provided informed consent for their own, and their child's participation. Following this, caregivers completed the *Caregiver Demographic Form*, as well as a preference assessment describing their child's preferred items/activities.

Time 1: Pre-Camp Caregiver-Child PECS Assessment and Child Psychological Assessment

A summary of the procedures is displayed in Figure 1. The T1 caregiver-child PECS assessments took place prior to the start of camp in the camp-clinic and home settings. During these assessments, the trained observer asked the caregiver to conduct five trials of each phase of PECS with their child to the best of their ability. The observer did not provide any direct training

or feedback to the caregiver or child. PECS assessments were approximately 15 to 30 mins in length.

At T1, children also participated in a comprehensive psychological assessment. Masters and doctoral graduate students in Clinical Psychology at York University conducted assessments. Doctoral-level, registered clinical psychologists supervised these students. While autism symptom severity measures (i.e., CARS-ST) and cognitive/developmental assessments (i.e., MSEL) were completed, caregivers completed the online version of the Vineland-3 Parent/Caregiver Rating Form. The psychological assessment was approximately 45 to 60 mins in length.

One-Week PECS Camp

Study participants were separated into two groups. Four caregiver-child dyads attended the morning camp session, and the other four caregiver-child dyads attended the afternoon session. Attempts were made to group children by age, while also taking child and family scheduling preferences into consideration (e.g., naptimes, work schedules). In the morning, the caregiver dropped their child off at camp and the child was supported by their assigned mediator to engage in camp activities and PECS communication opportunities for the first 2 hrs 30 mins. After 1 hr 30 mins passed, the caregiver returned to camp and participated in the 1-hr caregiver training session. Caregivers received coaching while working with their child for the last 30 mins of camp. The same format was implemented in the morning and afternoon sessions where each session was 3 hrs in total (See camp schedule; Appendix I).

PECSperts Caregiver Training Package: Caregiver Training. The first component of the 1-week PECS camp was the PECSperts Caregiver Training Package. As noted earlier, Part 1 of the PECSperts Caregiver Training Package involved caregiver training using BST and GCT to

teach the specified PECS phase of the day. Child participants were not involved in this part of the caregiver training. On day 1, caregivers watched a basic primer video on PECS and discussed the video content. The video described the purpose of PECS, general teaching strategies (e.g., prompting, reinforcement), and the overall PECS training structure. Caregiver trainers presented phase 1 on day 2, phase 2 on day 3, phase 3a on day 4, and phase 3b on day 5.

Caregiver trainers first provided written and verbal instructions to the caregivers on the specific PECS phase of the day. Next, caregivers watched an overview video demonstrating the steps required to teach the PECS phase. Following this, scenario video models designed to incorporate GCT were played. After watching each scenario video, caregivers practiced the PECS scenario with other participants. Trainers provided feedback to the caregivers, including praise for completing steps correctly and instructions to improve any missed or incorrect steps before moving on to the next video model of a new scenario. These procedures were repeated until all video models were completed for the day (i.e., 5–7 different scenarios per phase). In order to monitor caregiver PECS treatment integrity immediately after the caregivers practiced the specific PECS phase of the day, caregivers were asked to conduct three training probes with a confederate “child”. The trainer did not provide any feedback or support during the training probes. Trainers scored caregiver performance live using the *Caregiver Treatment Integrity Checklist*. Scoring was conducted in a manner identical to the T1 caregiver-child PECS assessments.

PECSperts Caregiver Training Package: Caregiver-Child Coaching. Part 2 of the PECSperts Caregiver Training Package direct caregiver-child coaching. Based on the child’s performance, the camp mediator and caregiver trainer provided teaching recommendations to the caregiver (i.e., types of reinforcers to offer, activities to embed PECS trials within, types of

prompts to provide). Next, caregiver trainers asked the caregivers if they were comfortable with the suggestions provided and explained the nature and sequence of activities that would occur during the coaching session. Finally, mediators modelled a few PECS trials, at the target phase, with their assigned child. Caregiver trainers then encouraged caregivers to practice teaching their child the target PECS phase and provided in-the-moment prompting (Gerow et al., 2021), and positive or corrective feedback as required. Caregivers implemented approximately 10 trials of PECS at the specific phase of the day while the trainer collected live data using the *Caregiver Treatment Integrity Checklist*. The number of trials varied depending on the child's motivation, energy level, mood, and other child-specific factors. During coaching sessions, for practical purposes and to facilitate timely feedback, caregivers received a score of "+" or "-" for their entire trial. A correct response was scored with a "+" for each trial that the caregiver completed every applicable item accurately. An incorrect response was scored with a "-" for each trial that the caregiver performed any item inaccurately or received in-the-moment prompting. The overall percentage of caregiver treatment integrity in each coaching session was calculated by adding the number of correct trials, dividing by the total number of trials, and multiplying by 100.

Child Teaching Sessions. The second component of the 1-week PECS camp involved direct child PECS teaching. Prior to teaching, mediators reviewed their assigned child's preference assessment. They then used this information to help guide a free operant preference assessment (Cooper et al., 2020) in the natural environment. Mediators offered potentially preferred items to each child and encouraged them to engage with the items. Those items commonly selected by the child, or those the child engaged with for longer durations, were used for PECS teaching. At a minimum, mediators were encouraged to re-evaluate child preferences

for every 10-trial block to identify currently preferred items in each location/activity for use during teaching.

Once mediators identified preferred items, PECS teaching commenced. Child teaching occurred naturally throughout camp using MET to teach PECS in different settings, during different activities, and with different reinforcers. A typical day at camp was composed of different activities such as morning play time, games, snack, arts and crafts, outside play time, centres (e.g., sand table, water table, playdoh), and caregiver-child coaching. A general schedule was created that prompted rotation between settings and activities across the session. PECS teaching was conducted in 10-trial blocks and to program for generalization, mediators were encouraged to conduct each 10-trial block in a different setting or activity using different categories of reinforcers. To ensure sufficient practice opportunities, mediators were encouraged to capture or contrive a minimum of 60 PECS trials per day (i.e., six, 10-trial blocks).

To monitor child progress during camp and to make decisions regarding PECS phase mastery and the need for program revision, mediators collected trial-by-trial data throughout the camp. Once 10 trials were conducted, the number of correct responses were added and divided by the total number of picture exchanges (trials). This was then converted to a percentage by multiplying by 100. Mediators recorded data on the types of items/activities requested, and the setting in which the interaction took place. These data were used to determine whether the child met the mastery criteria to progress to the next phase of PECS. Child mastery criteria for each phase was 80% accuracy across three blocks of 10 trials, over two reinforcers (e.g., 'cookie', 'ball'), and two different settings (e.g., playground, kitchen). Criteria to revise or review teaching procedures was a descending trend over three blocks of 10 trials or lack of phase mastery over 12 blocks of trials.

Time 2: Post-Camp Caregiver-Child PECS Assessment and Social Validity

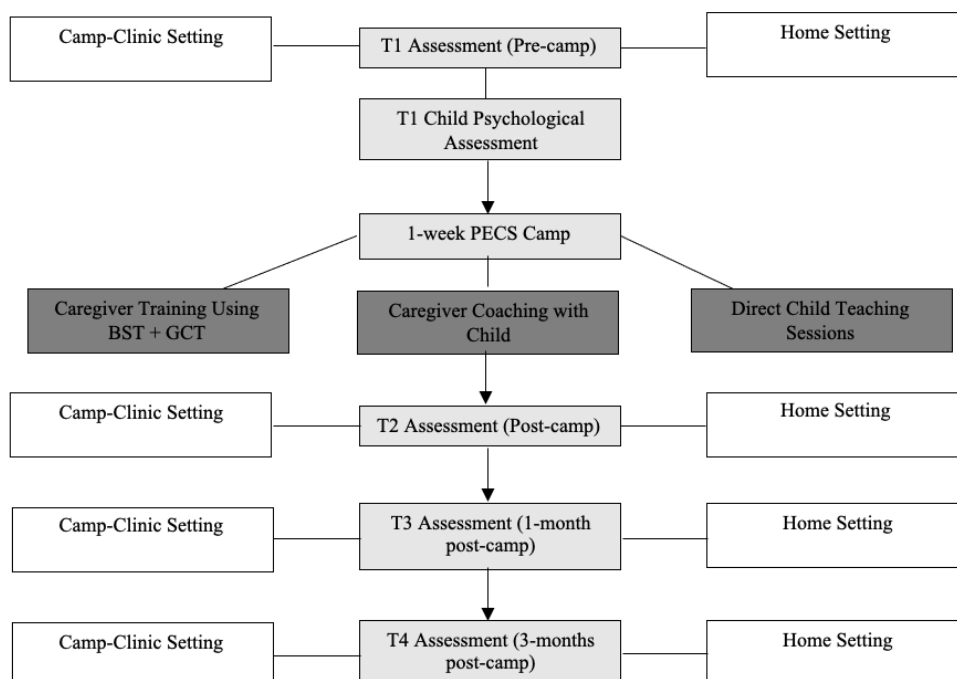
Within 1 week of the completion of camp, caregivers and children completed another PECS assessment in the camp-clinic and home settings. Time 2 caregiver-child PECS assessments were conducted in the same manner as T1 caregiver-child PECS assessments. The trained observer who conducted the PECS assessment also administered the social validity questionnaire to the caregiver in person, immediately after the T2 assessment was complete.

Time 3 and Time 4: Caregiver-Child PECS Maintenance Assessments

To determine if caregivers and children maintained their PECS skills following the completion of the camp, trained observers conducted maintenance assessments 1- and 3-months post-camp. Caregiver-child PECS assessments conducted at T3 and T4 were identical to those conducted at T1 and T2. Again, PECS assessments were conducted in the camp-clinic and home settings.

Figure 1

Procedures Flowchart



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post).

Interobserver Agreement

In both the camp-clinic and home settings, caregiver PECS treatment integrity and child PECS accuracy data were coded from video and IOA was calculated using the *Caregiver Treatment Integrity Checklist*. One rater who was naïve to the purpose and time points in the study was trained to >85% reliability. This individual coded and calculated IOA on 30% of caregiver treatment integrity videos across all four time points in the study. For caregiver treatment integrity, trial-by-trial IOA was conducted with a goal of maintaining $\geq 85\%$ agreement on checklist items (Cooper et al., 2020). An agreement was defined as two independent raters reporting the same caregiver integrity scores (i.e., both correct, both incorrect, both NA) for the same item. A disagreement was defined as two independent raters reporting different caregiver integrity scores (e.g., one correct and one incorrect) for the same item. For each PECS phase, at each time point, the number of agreements were summed and divided by the total number of items (i.e., agreements and disagreements), multiplied by 100. Average IOA for caregiver PECS treatment integrity in phase 1 was 93% (range 84%–100%), phase 2 was 93% (range 82%–100%), phase 3a was 95% (range 76%–100%), and phase 3b was 91% (range 81%–100%).

For child PECS accuracy, the same naïve rater coded the same randomly selected videos (i.e., 30% of assessments across all time points of the study) using trial-by-trial IOA. An agreement was defined as two independent raters reporting the same child accuracy score (i.e., both correct or both incorrect) for the same trial. A disagreement was defined as two independent raters reporting different child accuracy scores (i.e., one correct and one incorrect) for the same trial. For each PECS phase, at each time point, the number of agreements were added and

divided by the total number of agreements and disagreements and then converted to a percentage. For child PECS accuracy, average IOA in phase 1 was 93% (range 60%–100%), phase 2 was 89% (range 40%–100%), phase 3a was 95% (range 60%–100%), and phase 3b was 98% (range 80%–100%).

Mediator and Caregiver Trainer Procedural Fidelity

Mediator procedural fidelity was monitored using the *Mediator Procedural Fidelity Checklist* (Appendix J) to ensure mediators were implementing PECS as per the procedures outlined in Frost and Bondy (2002). A quasi-random selection process was used to ensure procedural fidelity checks were conducted for each camp mediator performing a 10-trial block of each PECS phase they taught. The first mediator who received a procedural fidelity check was selected at random and subsequent mediators were selected based on which phase they were teaching (to ensure each mediator was observed for procedural fidelity purposes at each phase), where they were located in the centre (for practical purposes), and whether they were conducting trials at the time of the checks (as opposed to engaging in other activities such as transitioning from one room to the next, toileting, etc). Some mediators did not reach the later phases with the participant they were working with (e.g., phase 3b), and thus, procedural fidelity was not collected on these phases for these specific mediators. Observations were videotaped, and data were collected from video. A “+” was recorded for every training component the mediator delivered correctly and a “-” was recorded for every training component the mediator delivered incorrectly or omitted. Steps that were not applicable (e.g., error correction on correct trials) were scored as “NA”. Data were converted to a percentage by adding the number of correct training steps, then dividing by the total number of correct and incorrect training steps and multiplying by 100. Mediators had an average procedural fidelity of 98% (range 91%–100%) in

phase 1, 100% in phase 2, 97% (range 94%–99%) in phase 3a, and 99% (range 99%–100%) in phase 3b.

Procedural fidelity was also monitored using the *Caregiver Coaching Procedural Fidelity Checklist* (Appendix K) to ensure the caregiver trainers were coaching as per the procedures. A random selection process was used to ensure procedural fidelity checks were conducted for a minimum of 30% (range 30%–66%) of each caregiver trainer’s coaching sessions. Observations were videotaped and one of the trained observers collected data from video. In the coaching session, a “+” was recorded if the caregiver trainer completed the step correctly and a “-” was recorded if the caregiver trainer omitted or incorrectly delivered a step. A “NA” was recorded for steps that were not applicable. Data were converted to a percentage by adding the number of correct steps, dividing by the total number of correct and incorrect steps, and multiplying by 100. Caregiver trainers had an average procedural fidelity of 93% (range 86%–100%) in phase 1, and 100% in phases 2, 3a, and 3b.

Data Analysis

To answer research question one related to child PECS outcomes from T1 to T2, maintenance at T3 and T4, and generalization to the home setting, we first calculated descriptive statistics (i.e., mean, standard deviation [*SD*], range) for child PECS accuracy across PECS phases and settings. We then graphed the data to allow for visual inspection across all timepoints. Wilcoxon-signed rank tests were then completed to determine if there were significant differences between child PECS accuracy at T1 and T2 in the camp-clinic and separately in the home. Additional Wilcoxon-signed rank tests were conducted to compare the camp-clinic and home scores at T2, T3, and T4 to determine if performance in the camp-clinic and home settings significantly differed at any timepoint.

To answer research question two on caregiver outcomes from T1 to T2 following the 1-week PECS camp, maintenance at T3 and T4, and generalization to the home setting, descriptive statistics were calculated (i.e., mean, *SD*, range) for caregiver PECS treatment integrity across PECS phases and settings. We then graphed the data to allow for visual inspection over time. The following statistical analyses were then completed: (a) Wilcoxon-signed rank tests to determine if there were significant differences between T1 and T2 in the camp-clinic and home settings, (b) Wilcoxon-signed rank tests to determine if there were significant differences between settings at T2, T3, and T4.

To answer research question three on the acceptability and effectiveness of PECS, the brief camp format, and the PECSperts Caregiver Training Package from the caregiver's perspective, we analyzed the social validity questionnaires using descriptive statistics. The mean, *SD*, and range were calculated and compared for each question. The two open-ended questions were analyzed separately, and common themes were identified in each question and grouped.

Results

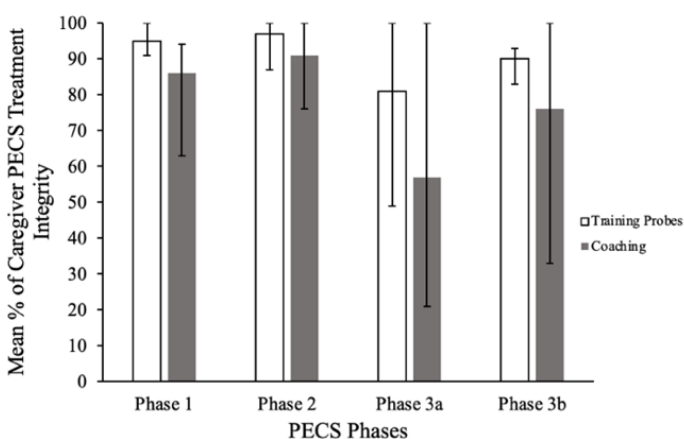
Caregiver PECS Treatment Integrity

Figure 2 and Table 2 display average caregiver PECS treatment integrity during training probes (conducted with a confederate immediately following BST) and caregiver-child coaching sessions (conducted with participating children during daily camp sessions). Average caregiver PECS treatment integrity, across all four PECS phases, ranged from 81% to 97% during training probes. The group means for phases 1, 2, and 3b were above 90% with limited range, suggesting all caregivers performed these phases with high levels of accuracy. However, phase 3a had a lower group mean—although still above the generally accepted value of 80%—and a larger range of caregiver scores (i.e., range 49%–100%), indicating variability in performance across

caregivers. Average caregiver PECS treatment integrity remained relatively high during caregiver-child coaching sessions for phases 1 and 2 (i.e., $\geq 85\%$). However, treatment integrity was markedly lower for phases 3a and 3b (i.e., $M = 57\%$, range 21%–100%; $M = 76\%$, range 33%–100%, respectively). These results suggest that immediately following training, most caregivers demonstrated proficiency implementing PECS phases 1 and 2 with their children. However, their proficiency implementing phases 3a and 3b was not as well developed.

Figure 2

Average Caregiver PECS Treatment Integrity in Camp Training Probes and Caregiver-Child Coaching



Notes. Caregivers completed training probes with a confederate. Caregivers completed coaching trials with their child. $N = 7$ phase 1 training, coaching; $N = 8$ phase 2 training; $N = 7$ phase 2 coaching; $N = 7$ phase 3a training; $N = 6$ phase 3a coaching; $N = 8$ phase 3b training; $N = 7$ phase 3b coaching.

Table 2

Average Caregiver Treatment Integrity Separated by PECS Phase and Study Condition

PECS Phase	Caregiver PECS Treatment Integrity	
	PECS Assessments (Combined Settings)	Camp
Phase 1		
Phase 2		
Phase 3a		
Phase 3b		

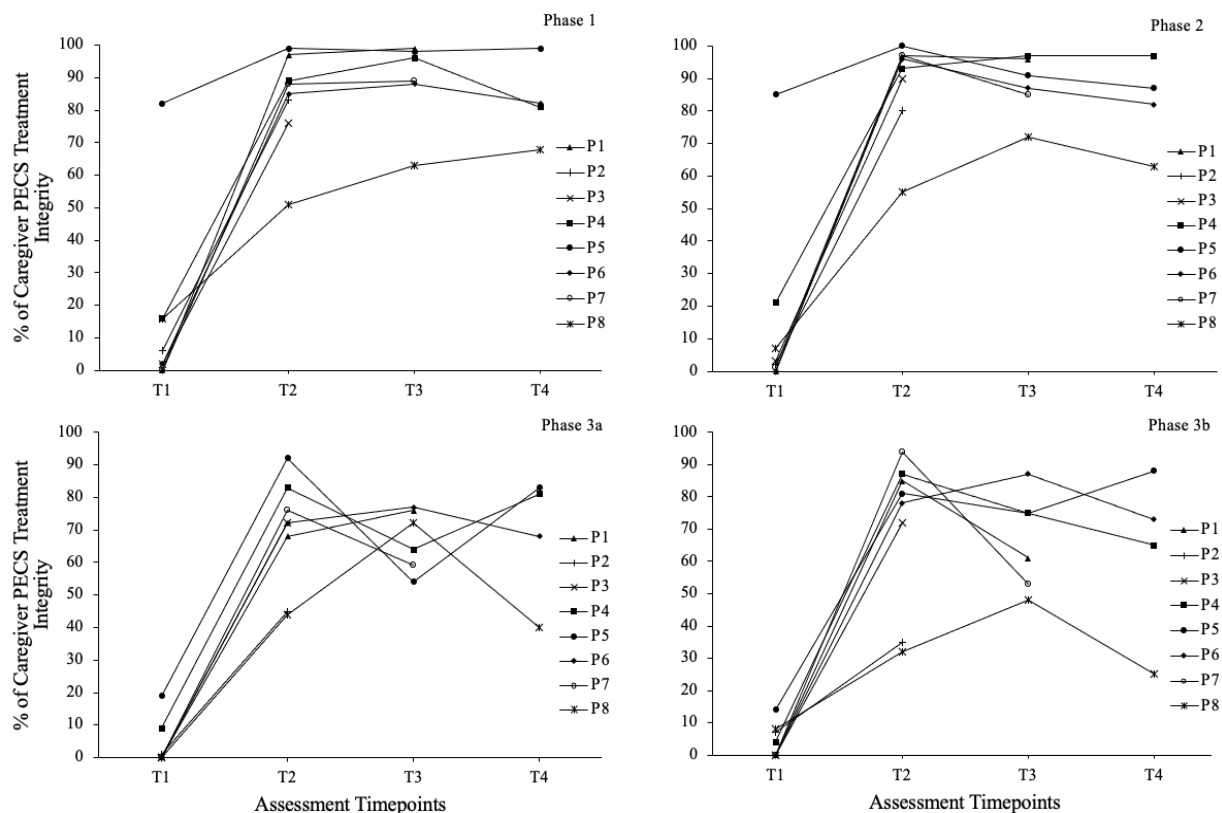
	T1	T2	T3	T4	Training Probes	Coaching
Phase 1 <i>M(SD)</i>	15% (28%)	83% (15%)	89% (13%)	83% (13%)	95% (4%)	86% (44%)
Range	0%–82%	51%–99%	63%–99%	68%–99%	91%–100%	63%–94%
Phase 2 <i>M(SD)</i>	14% (29%)	88% (15%)	88% (9%)	82% (14%)	97% (5%)	91% (38%)
Range	0%–81%	55%–100%	72%–97%	63%–97%	87%–100%	76%–100%
Phase 3a <i>M(SD)</i>	4% (7%)	69% (17%)	67% (9%)	68% (20%)	81% (20%)	57% (31%)
Range	0%–19%	44%–92%	54%–77%	40%–83%	49%–100%	21%–100%
Phase 3b <i>M(SD)</i>	4% (5%)	70% (24%)	66% (15%)	62% (27%)	90% (3%)	76% (30%)
Range	0%–14%	32%–87%	48%–87%	25%–88%	83%–93%	33%–100%

Notes. PECS assessments include combined data from both camp-clinic and home settings. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4; $N = 7$ phase 1 training, coaching; $N = 8$ phase 2 training; $N = 7$ phase 2 coaching; $N = 7$ phase 3a training; $N = 6$ phase 3a coaching; $N = 8$ phase 3b training; $N = 7$ phase 3b coaching.

Figure 3 displays individual caregiver PECS treatment integrity, separated by PECS phase, in combined settings at each assessment timepoint. In each PECS phase, caregivers generally did not implement PECS accurately with their child at T1, as evidenced by low treatment integrity. At T2, caregiver treatment integrity generally increased in all PECS phases. However, there were multiple caregivers whose teaching accuracy did not substantially improve (e.g., phase 3b; participant 8). At T3 and T4, caregivers generally maintained their skills in phases 1 and 2; however, caregiver performance was less stable for phases 3a and 3b. These results suggest that a brief model may be more beneficial for teaching caregivers the earlier phases of PECS compared to the later phases. To gain a more comprehensive understanding of trends across participants, data were grouped and analyzed.

Figure 3

Individual Caregiver Treatment Integrity Separated by PECS Phase in Combined Settings



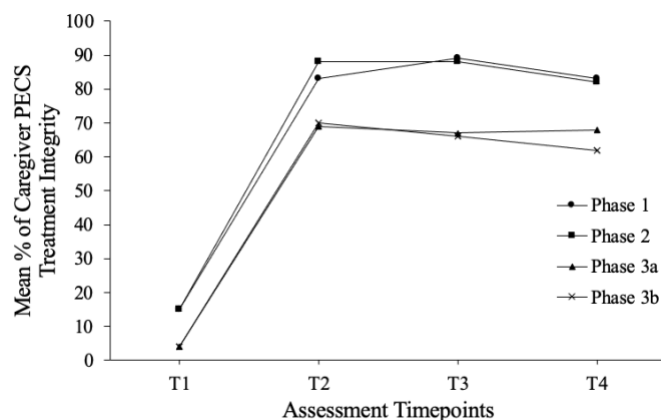
Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4. Participant 5's child was recently introduced to PECS and participant 5 observed his training session. This may account for higher T1 scores in phases 1 and 2.

Average caregiver PECS treatment integrity, separated by PECS phase in combined settings is depicted in Figure 4 and Table 2. At T1, average caregiver PECS treatment integrity, for each phase of PECS, was low (i.e., $\leq 15\%$). At T2, average caregiver PECS treatment integrity increased across all phases. Average caregiver PECS treatment integrity increased to approximately 85% for phases 1 and 2, and to approximately 70% for phases 3a and 3b. These gains were generally maintained at T3 and T4. Overall, these data suggest that following the implementation of the brief 1-week PECS camp, average caregiver treatment integrity across all phases of PECS improved and maintained from T2 to T4. However, more substantial

improvements were noted in phases 1 and 2. Further, the wide range of treatment integrity across all PECS phases suggest substantial individual variability (e.g., T4, phase 3b, range 25%–88%).

Figure 4

Average Caregiver Treatment Integrity Separated by PECS Phase in Combined Settings



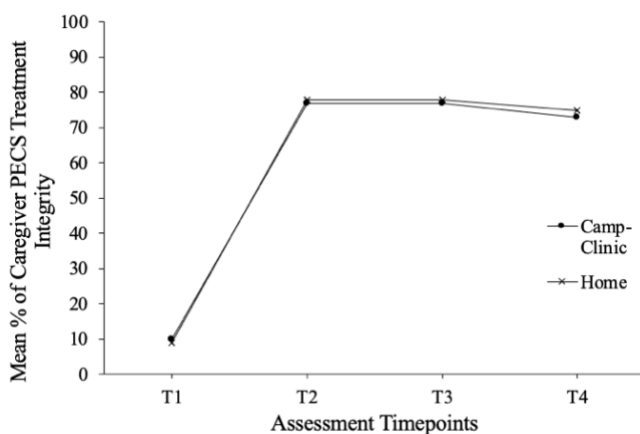
Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

Figure 5 and Table 3 depict average caregiver treatment integrity across all PECS phases separated by camp-clinic and home settings. At T1, average caregiver PECS treatment integrity was approximately 10% in both settings. At T2, average caregiver PECS treatment integrity increased to over 75% in both settings. The results of Wilcoxon signed rank tests indicate this increase was significant, and there was a large effect size, in both the camp-clinic ($z = -2.524$, $p = .012$, $r = -.631$) and home ($z = -2.521$, $p = .012$, $r = -.630$) settings. Caregiver performance maintained in both settings at T3 and T4. Additional Wilcoxon signed rank tests indicate there were no significant differences between settings at T2 ($z = -.594$, $p = .553$), T3 ($z = -.524$, $p = .600$), or T4 ($z = -.552$, $p = .581$). These results suggest the skills learned in the camp-clinic setting generalized to the home setting and there were no significant differences between caregiver performance in either setting over time. However, the broad range in caregiver PECS

treatment integrity from T2 to T4 in both settings highlight substantial individual variability in performance (e.g., T4, home setting, range 19%–100%).

Figure 5

Average Caregiver Treatment Integrity Across all PECS Phases Separated by Camp-Clinic and Home Settings



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

Table 3

Average Caregiver Treatment Integrity Across all PECS Phases Separated by Camp-Clinic and Home Settings

Setting	Caregiver PECS Treatment Integrity			
	T1	T2	T3	T4
Camp-Clinic $M(SD)$	10% (20%)	77% (20%)	77% (18%)	73% (19%)
Range	0%–84%	30%–100%	40%–100%	30%–98%
Home $M(SD)$	9% (21%)	78% (20%)	78% (16%)	75% (22%)
Range	0%–84%	33%–100%	53%–100%	19%–100%

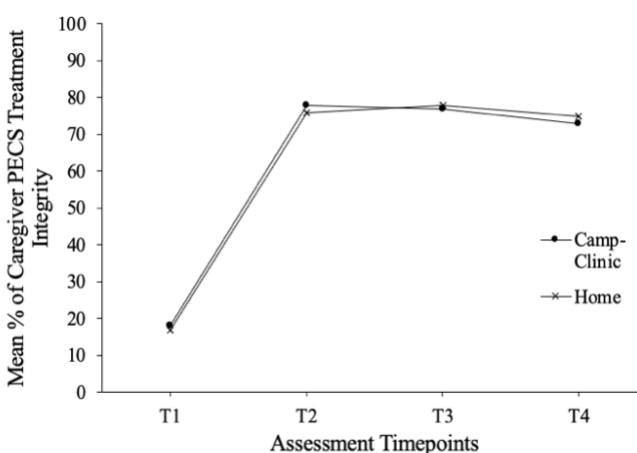
Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

To accommodate for participant attrition during T3 and T4 and to ensure a comprehensive analysis, Figure 6 displays average caregiver PECS treatment integrity across all

PECS phases separated by camp-clinic and home settings for caregivers who completed assessments at all four timepoints. Similar to the results of the entire sample, depicted in Figure 5, caregiver treatment integrity of this subset of participants increased substantially from T1 to T2, and generally maintained at T3 and T4 in both settings.

Figure 6

Average Caregiver Treatment Integrity Across all PECS Phases Separated by Camp-Clinic and Home Settings for Caregivers who Completed T1 to T4 Assessments



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 4$ T1, T2, T3, T4.

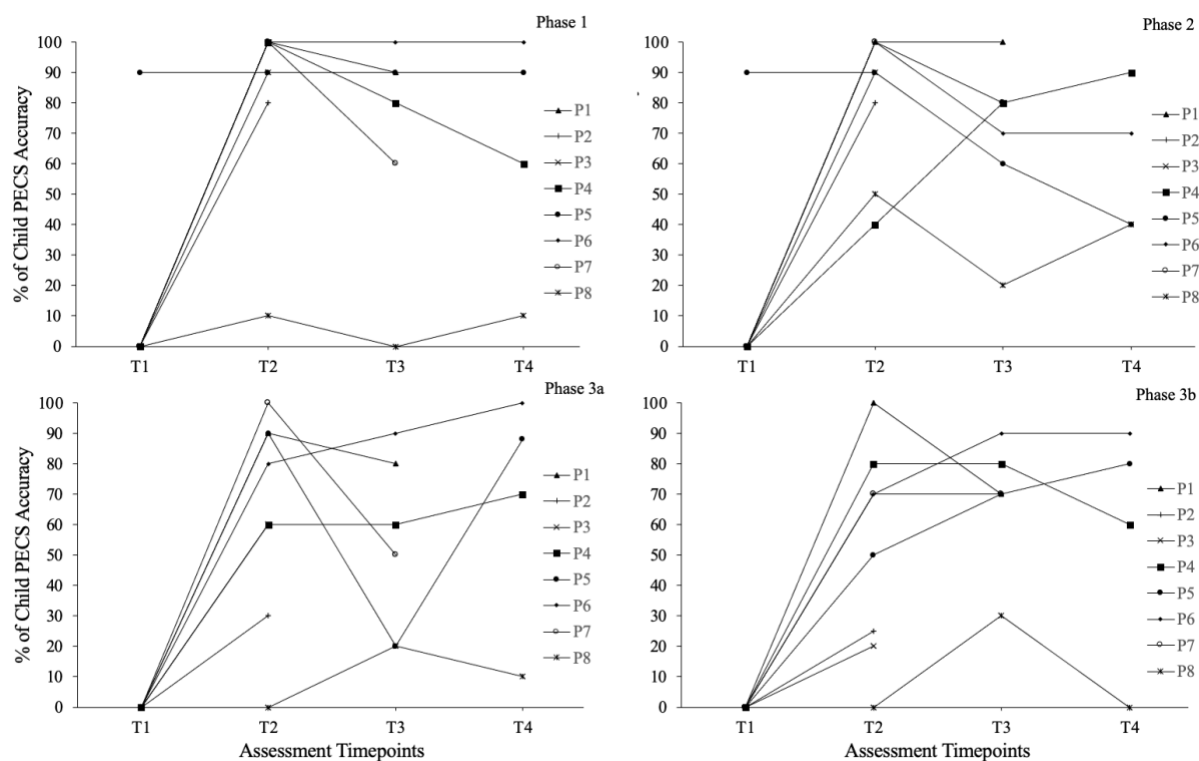
Child PECS Accuracy

Figure 7 displays individual child PECS accuracy separated by PECS phase in combined settings and Table 4 displays the number and percentage of children who demonstrated mastery of each PECS phase at T1 and T2. Of the eight children evaluated at T1, 13% demonstrated mastery of phase 1 (1 child), 13% phase 2 (1 child), 0% phase 3a (0 children), and 0% phase 3b (0 children). At T2, of the eight children evaluated, 88% demonstrated mastery of phase 1 (7 children), 75% phase 2 (6 children), 50% phase 3a (4 children), and 25% phase 3b (2 children). After the brief 1-week PECS camp, one child demonstrated mastery of 4 PECS phases, three

children demonstrated mastery of 3 PECS phases, three demonstrated mastery of 2 PECS phases, and one child did not demonstrate mastery of any PECS phases. At T3, two participants were lost to follow-up. Of the six children remaining at T3, 66% demonstrated mastery of phase 1 (4 children), 50% phase 2 (3 children), and 33% phases 3a and 3b (2 children). Further attrition led to only four children completing the 3-month maintenance assessment. Of the four children at T4, 50% demonstrated mastery of phase 1 (2 children), 25% phase 2 (1 child), and 50% phases 3a and phase 3b (2 children). To better understand individual child patterns, data were grouped and analyzed.

Figure 7

Individual Child Accuracy Separated by PECS Phase in Combined Settings



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4. Participant 5 had been recently introduced to

PECS and demonstrated some proficiency in phases 1 and 2; however, he had not mastered the system so met inclusion criteria.

Table 4

Summary of Child PECS Mastery in Combined Settings

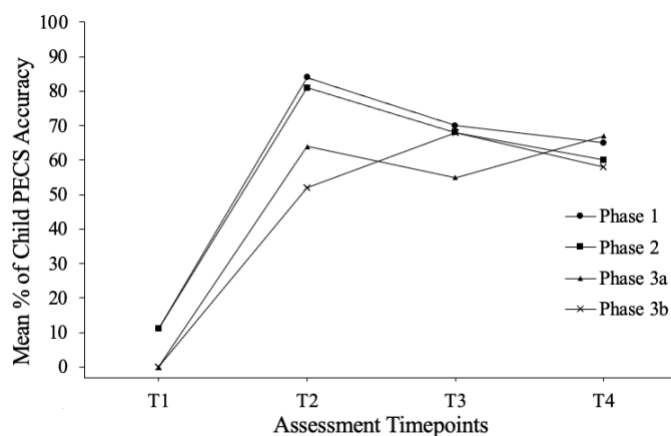
PECS Phase	Number and Percentage of Children Who Demonstrated Mastery of Each PECS Phase	
	T1 <i>N</i> (%)	T2 <i>N</i> (%)
Phase 1	1 (13%)	7 (88%)
Phase 2	1 (13%)	6 (75%)
Phase 3a	0 (0%)	4 (50%)
Phase 3b	0 (0%)	2 (25%)

Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post). *N* = 8 T1, T2.

Average child PECS accuracy, separated by phase in combined settings is depicted in Figure 8 and Table 5. At T1, average child PECS accuracy was low in each phase of PECS (i.e., $\leq 11\%$). At T2, average child PECS accuracy increased across all phases. Average child PECS accuracy increased to levels above 80% for phases 1 and 2, 60% for phase 3a, and 50% for phase 3b. At T3, average child PECS accuracy was approximately 70% for phases 1, 2, and 3b, and 50% for phase 3a. This level of responding slightly changed at T4, with an average child PECS accuracy of approximately 65% for phases 1 and 3a and 60% for phases 2 and 3b. Overall the data indicate steep increases in child performance from T1 to T2. However, for phases 1 and 2 there was a decreasing trend from T2 to T4. Further, performance on phases 3a and 3b consistently remained below the desired standard of 80% across T2 to T4. In addition, there was a wide range of child PECS accuracy in all phases, suggesting substantial individual variability (e.g., T2, phases 3a and 3b, range 0%–100%). These results indicate that child PECS maintenance was variable across the phases.

Figure 8

Average Child Accuracy Separated by PECS Phase in Combined Settings



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

Table 5

Average Child Accuracy Separated by PECS Phase in Combined Settings

PECS Phase	Child PECS Accuracy			
	T1	T2	T3	T4
Phase 1 <i>M(SD)</i>	11% (32%)	84% (31%)	70% (37%)	65% (40%)
Range	0%–90%	10%–100%	0%–100%	10%–100%
Phase 2 <i>M(SD)</i>	11% (32%)	81% (24%)	68% (27%)	60% (24%)
Range	0%–90%	40%–100%	20%–100%	40%–90%
Phase 3a <i>M(SD)</i>	0%	64% (34%)	53% (30%)	67% (40%)
Range		0%–100%	20%–90%	10%–100%
Phase 3b <i>M(SD)</i>	0%	52% (34%)	68% (20%)	58% (40%)
Range		0%–100%	30%–90%	0%–90%

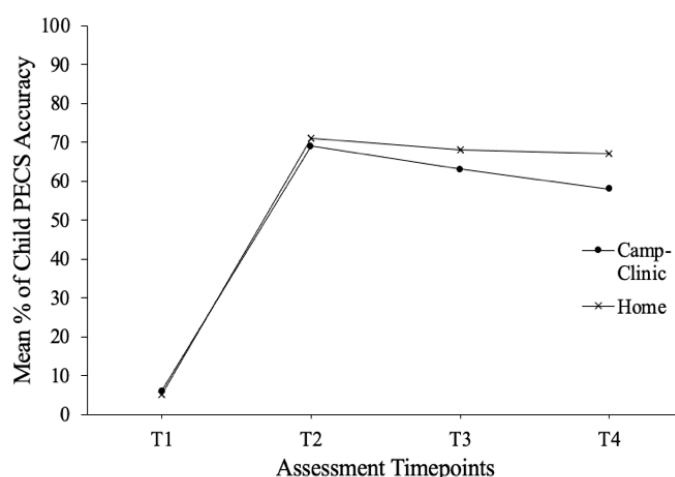
Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

Figure 9 and Table 6 display average child PECS accuracy across all PECS phases separated by camp-clinic and home settings. At T1, average child PECS accuracy was approximately 5% in both settings. Wilcoxon signed rank tests were conducted to determine

statistical differences between T1 and T2, and results suggest average child PECS accuracy significantly increased to approximately 70% in the camp-clinic ($z = -2.521, p = .012, r = -.630$) and home ($z = -2.524, p = .012, r = -.631$) settings with a large effect. These gains generally maintained in the home setting with group mean scores remaining close to 70% at T3 and T4. Similarly, child improvements from baseline were observed in the camp-clinic setting at T3 and T4; however, there was a notable decreasing trend from T2 to T4 with the average score falling to below 60% at T4. Additional Wilcoxon signed rank tests were conducted and results indicate there were no statistically significant differences between settings at T2 ($z = -.420, p = .674$), T3 ($z = -.524, p = .600$), or T4 ($z = -1.089, p = .276$). These results suggest that the skills learned in the camp-clinic setting generalized to the home setting and there were no significant differences between child performance in either setting over time. The broad range in child PECS accuracy from T2 to T4 in both settings highlight substantial individual variability in performance (e.g., T4, camp-clinic and home, range 0%–100%).

Figure 9

Average Child Accuracy Across all PECS Phases Separated by Camp-Clinic and Home Settings



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

Table 6

Average Child Accuracy Across all PECS Phases Separated by Camp-Clinic and Home Settings

Setting	Child PECS Accuracy			
	T1	T2	T3	T4
Camp-Clinic <i>M(SD)</i>	6% (25%)	69% (36%)	63% (39%)	58% (42%)
Range	0%–100%	0%–100%	0%–100%	0%–100%
Home <i>M(SD)</i>	5% (20%)	71% (34%)	68% (29%)	67% (37%)
Range	0%–80%	0%–100%	0%–100%	0%–100%

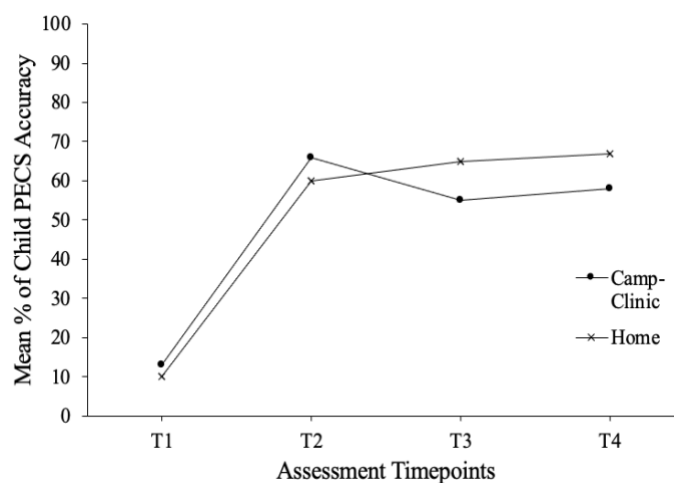
Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4

(3-months post). $N = 8$ T1, T2; $N = 6$ T3, $N = 4$ T4.

Figure 10 depicts average child PECS accuracy across all PECS phases separated by camp-clinic and home settings for the subset of children who completed assessments at all four timepoints. Similar to the results of the larger group, depicted in Figure 9, child accuracy for the subset increased from T1 to T2 in both settings. At T3 and T4, child PECS accuracy slightly increased in the home setting and maintained over time. In the camp-clinic setting, there was a notable decreasing trend from T2 to T3; however, child accuracy at T4 remained similar to T3.

Figure 10

Average Child Accuracy Across all PECS Phases Separated by Camp-Clinic and Home Settings for Children who Completed T1 to T4 Assessments



Notes. T1 = Time 1 (pre), T2 = Time 2 (1-week post), T3 = Time 3 (1-month post), T4 = Time 4 (3-months post). $N = 4$ T1, T2, T3, T4.

Social Validity

Table 7 depicts the mean, *SD*, and range of social validity questions on the TARF-R. The first set of questions highlighted caregivers' experience learning to teach PECS. Clarity, likelihood of implementation following caregiver training and the 1-week camp, and overall acceptability ranged from 1–5 ($M = 4.4$). Most caregivers reported they understood and were able to implement PECS fairly well following participation in PECSperts Caregiver Training and found the PECS training and coaching to be very acceptable.

The next set of questions focussed on caregivers' experience teaching their child PECS. Caregivers found PECS to be very acceptable for their child, they were very willing to carry out PECS teaching with their child, and they believed the treatment would make ongoing improvements to their child's communication skills ($M = 4.5$, range 3–5). Additionally, average caregiver scores ranged from 3 to 5 ($M = 4.4$) on the degree to which their child's communication difficulties were a concern to them and how reasonable they found PECS given their child's needs. Although caregivers believed their child's communication difficulties were a concern, they scored the severity of their child's communication difficulties as *neutral to moderately severe* ($M = 3.6$, range 3–5). In terms of effectiveness, caregivers were confident PECS would be effective ($M = 4.3$, range 3–5) and believed PECS would specifically be very effective for their child ($M = 4.8$, range 4–5). They also liked the PECS teaching procedures and were willing to continue supporting their child's PECS use ($M = 4.1$, range 3–5). Although caregivers noted they were willing to change their family routine to accommodate PECS ($M = 4.6$, range 3–5), willingness of family members to help carry out PECS ranged from 2 to 4 ($M =$

3.1), and how well PECS would fit into their family routine ranged from 1 to 5 ($M = 3.5$). These results suggest that although caregivers may be willing to change their family routine, family members may not be as willing. Further, PECS may not fit into every family's routine. On questions that were reverse scored on a 5-point Likert scale, scores on undesirable side effects and discomfort ranged from 1 to 3 ($M = 1.5$). Caregivers did not believe there were many undesirable side effects from PECS, or much discomfort experienced by their child during camp. In terms of disadvantages in teaching PECS, scores ranged from 1 to 5 ($M = 2.1$). These results suggest most caregivers did not identify many disadvantages in the PECSperts Caregiver Training and/or PECS.

Common themes were identified in caregivers' responses on the open-ended questions. Caregivers generally reported that they enjoyed the hands-on training, small group practice, and practice with their own child. They noted the training was "great" and "informative." Additionally, some caregivers reported the camp provided their child with specific benefits, such as assisting their child through daily transitions and facilitating their child's comprehension of what is expected of them. Specific training features that were identified as beneficial included back-prompters and handouts to use at home. In terms of least helpful or the least preferred aspect of training, some caregivers expressed that there was nothing that they did not like. Multiple caregivers suggested practicing with their child at the beginning of the session may have proved more advantageous than the end. This is due to some children becoming tired, satiated on reinforcers and camp activities, and/or eager to go home by the end of the session. Another caregiver believed it was a little inconvenient, but worth it, to drop their child off and then return later for the caregiver training. Further, one caregiver was happy to be a part of the study; however, the video recording made her feel anxious. Finally, one caregiver did not believe

she had enough pictures that aligned with her child to continue, or clear information as to where her child was at and what next steps were necessary. Overall, these results suggest that most caregivers found the training acceptable and effective, with only a few recommendations for improvement.

Table 7

Summary of Caregiver Social Validity Ratings

Social Validity Questions	<i>M</i> (<i>SD</i>) Range
How clear was your understanding of PECS following the hands-on coaching (behavioural skills training)?	4.3 (1.4) 1–5
How well did you think you could implement PECS following the hands-on coaching (behavioural skills training)?	4.6 (0.7) 3–5
How well did you think you could implement PECS following the 1-week camp?	3.8 (0.9) 3–5
OVERALL, how acceptable did you find the PECS training and coaching that you received?	4.9 (0.4) 4–5
How acceptable did you find PECS for your child?	4.5 (0.8) 3–5
How willing were you to carry out PECS teaching with your child?	4.5 (0.8) 3–5
Given your child’s needs, how reasonable did you find PECS?	4.4 (0.8) 3–5
To what extent did you think there were disadvantages in teaching PECS?	2.1 (1.4) 1–5
How likely is this treatment to make ongoing improvements in your child’s communication skills?	4.5 (0.9) 3–5
To what degree were your child’s communication difficulties of concern to you?	4.4 (0.9) 3–5
How confident were you that PECS would be effective?	4.3 (0.9) 3–5
How effective did you think PECS was for your child?	4.8 (0.5) 4–5
How much did you like the teaching procedures used in PECS?	4.1 (1.0) 3–5
How willing were other family members to help carry out PECS? (Circle NA if not applicable)	3.1 (0.7) 2–4
To what extent did undesirable side-effects result from PECS?	1.3 (0.7) 1–3

How much discomfort (if any) did your child experience during the course of camp?	1.6 (1.3) 1–3
How severe were your child’s communication difficulties?	3.6 (0.7) 3–5
How willing are you to continue to support your child’s PECS use? (Circle NA if not applicable)	4.1 (0.6) 3–5
How willing are you to change your family routine to carry out PECS? (Circle NA if not applicable)	4.6 (0.7) 3–5
How well do you think PECS will fit into your family routine? (Circle NA if not applicable)	3.5 (1.2) 1–5

Notes. $N = 8$.

Discussion

The purpose of this study was to explore the impact of a brief combined caregiver and child PECS camp on caregiver PECS implementation and child PECS outcomes, and to report on caregiver and child skill generalization and maintenance.

Average caregiver PECS treatment integrity substantially increased from baseline to T2, following participation in the PECSperts Caregiver Training Package. These results align with prior research that demonstrates that caregiver PECS teaching skills improve following participation in caregiver PECS training (e.g., Alsayedhassan et al., 2020; Chaabane et al., 2009; Park et al., 2011; Stiebel, 1999; Treszl et al., 2021). Similarly, caregiver improvements are consistent with the positive outcomes reported in prior BST and GCT research (e.g., Alaimo et al., 2018; Ducharme & Feldman, 1992; Seiverling et al., 2010; Ward-Horner & Sturmey, 2008) suggesting the combination of BST plus GCT may be an effective method of training caregivers. Notably, this study extends the work of Treszl et al. (2021) who established preliminary evidence for caregiver PECS training using a BST plus GCT training strategy. However, Treszl et al. (2021) only examined participant outcomes for one phase of PECS with one family, compared to the present study which examined four phases with eight families.

Importantly, the results of this study provide greater insight into caregiver PECS treatment integrity across PECS phases. For example, the results suggest more substantial improvements in caregiver PECS treatment integrity in phases 1 and 2 compared to phases 3a and 3b, as well as variability in treatment integrity across caregivers. Phases 3a and 3b have more implementation steps (Bondy & Frost, 1994) and more complex error correction procedures (Treszl et al., 2021). These factors may contribute to lower teaching accuracy (e.g., Allen & Warzak, 2000). Methodological factors may have also impacted caregiver PECS outcomes. Given the nature of the brief intervention, not all caregivers met the pre-determined performance criterion during practice trials, which is generally a requirement during BST (Miltenberger, 2008). Further, during caregiver-child coaching sessions, it is common practice to provide live feedback and support to the caregiver (e.g., Gerow et al., 2021); however, since the child may behave differently on subsequent trials, caregivers may not have the opportunity to implement this feedback, reducing opportunities for correct practice. Next, several components of phases 1 and 2 are also present in phases 3a and 3b (e.g., setting up the communication opportunity, silently enticing). This allows caregivers to repeatedly practice these components and refine their skills; the same opportunity is not available for the new components in the advanced phases (e.g., correspondence checks, four-step error correction). Finally, if children did not reach higher phases in camp, caregivers may have had less practice opportunities on these phases. Together, the results suggest that time-limited service models may be adequate for training early PECS phases (i.e., phases 1 and 2); however, the limitations associated with a brief model, including reduced practice opportunities and lack of achievement of predetermined performance criterion, may reduce the effectiveness of brief interventions for teaching more complex PECS phases (i.e., phases 3a and 3b). Booster sessions may be required to ensure

caregivers achieve appropriate levels of implementation accuracy for these higher phases. Further, future studies utilizing a brief PECS training model should attempt to create additional practice opportunities for higher PECS phases and ensure caregivers reach a mastery criterion of 90% (Nigro-Bruzzi & Sturmey, 2010) to support more accurate PECS implementation.

The factors that impact treatment integrity, described above, may also impact caregiver skill maintenance. Similar to Treszl et al (2021), the results of the present study indicate caregivers generally maintained the same level of PECS teaching accuracy from T2 to T3 and T4. It is possible that the same factors that impacted caregiver accuracy in phases 3a and 3b at T2 (i.e., reduced practice opportunities, lack of achievement of predetermined performance criterion) also impacted caregiver accuracy at T3 and T4. If caregivers were trained to higher treatment integrity in the more advanced phases during camp, it is possible that they would have maintained their skills at higher levels. While investigating maintenance (i.e., measuring behaviour after complete withdrawal of intervention; Pennington et al., 2019) contributes to the existing literature, given the lower levels of caregiver treatment integrity in phases 3a and 3b in the present study, collecting follow-up data (i.e., measuring behaviour while continuing intervention; Pennington et al., 2019) may be more beneficial for children and caregivers.

The results of the present study also indicate that caregiver PECS skills generalized to the home setting. The only published study on caregiver PECS generalization, Treszl et al. (2021), discovered that some PECS skills (i.e., setting up communication opportunity, conducting correspondence checks) generalized to the home setting; however, they determined error correction did not generalize to the same extent. Results of the present study builds upon the results of Treszl et al. (2021) and provide additional evidence for the effectiveness of using a

BST plus GCT model to train caregivers and develop their repertoire of PECS skills in the natural environment.

Consistent with caregiver results, average child PECS accuracy across all phases generally increased from baseline to T2, following the 1-week PECS camp. These results align with the existing literature that generally demonstrates the effectiveness of PECS teaching (e.g., Carr & Felce, 2007; Carre et al., 2009; Charlop-Christy et al., 2002; Cummings et al., 2012; Koudys et al., 2021; Lerna et al., 2012). Similar to Carr and Felce (2007), results indicate children made more substantial increases in phases 1 and 2 compared to phases 3a and 3b after a brief intervention. Lower accuracy in the higher phases may be attributed to procedural differences, methodological factors, and/or child characteristics. First, children in the present study received only 15 hrs of teaching, compared to children in other studies who received more teaching hours and learned more phases (e.g., Carre et al., 2009; Cummings et al., 2012; Koudys et al., 2021; Lerna et al., 2012). Therefore, longer intervention time may be required to support the acquisition of higher phases. Next, the present study used a stringent mastery criterion of 80% accuracy across three 10 trial-blocks, over two reinforcers and two settings. This stringent criterion may have slowed down the rate of PECS phase mastery in comparison to studies that only required 80% accuracy across one 10-trial block for their mastery criteria (e.g., Charlop-Christy et al., 2002). In addition, methodological components that may have impacted child outcomes at all timepoints include: (a) PECS assessments conducted back-to-back leading to satiation (Michael, 2007), and (b) only five trials at each phase in PECS assessments resulting in range restriction (Stoolmiller, 1999). Finally, individual child characteristics such as joint attention (e.g., Flippin et al., 2010; Yoder & Stone, 2006a, 2006b), motor imitation (e.g., Flippin et al., 2010; Tincani, 2004), and object exploration (e.g., Flippin et al., 2010; Yoder & Stone,

2006a, 2006b) may have impacted the acquisition of PECS skills. An interactive effect between any combination of these variables may have affected children's PECS implementation accuracy.

In terms of child PECS maintenance, performance was variable. In the literature, some studies suggest children maintain their skills (e.g., Charlop-Christy et al., 2002; Greenberg et al., 2012; Lerna et al., 2014; Odluyurt et al., 2016; Park et al., 2011) whereas others suggest they do not (e.g., Howlin et al., 2007; Jurgens et al., 2019). The variability in child PECS accuracy from T2 to T4 may be the result of numerous factors. For example, individual child characteristics may have impacted PECS skill attainment at T2 (as described above), as well as PECS skill maintenance at T3 and T4 (e.g., Flippin et al., 2010). Different profiles of child strengths and weaknesses may result in different child outcomes, including some children making limited progress throughout all phases and timepoints, others achieving relatively high accuracy throughout all phases and timepoints, and others demonstrating high accuracy at T2 in most phases, and lower accuracy at subsequent timepoints. Similar to caregiver outcomes, these results suggest that some children may need additional help, such as booster sessions, to support skill attainment and maintenance. Changes in teaching priorities or practice may have also contributed to variability in child performance during maintenance assessments (specifically the decreasing trend in phases 1 and 2). As children demonstrated mastery of some phases (e.g., phases 1 and 2), caregivers may have decreased training on those phases to increase training on subsequent phases (e.g., phases 3a and 3b), resulting in lower proficiency in the phases that were not practiced as much. To ensure children improve and maintain achieved gains in important skill areas, such as seeking out their PECS binders and communicative partners and demonstrating persistent communication skills (e.g., phase 2), additional supports (e.g., ongoing consultation, booster sessions) may be necessary.

Child PECS generalization was also investigated. Results of the present study were consistent with those of Dogoe et al. (2010) and Koudys et al. (2021) as all studies establish that child PECS skills generalized to the home. Two factors that may have contributed to the generalization of skills across settings include creating communication opportunities across settings (e.g., Charlop-Christy et al., 2002; Dogoe et al., 2012; Koudys et al., 2021) and teaching using MET (e.g., Dogoe et al., 2010; Koudys et al., 2021). In addition, it is possible that children spent more time practicing in the home compared to the camp-clinic, resulting in increased PECS proficiency in the home. Similarly, a slight decrease in child PECS accuracy in the camp-clinic setting over time may be attributed to a lack of practice in this setting after the completion of the camp. Results of the present study make a meaningful contribution to the literature related to child PECS generalization and provide additional evidence for the effectiveness of creating teaching opportunities across multiple settings while simultaneously using MET (Stokes & Baer, 1977) to promote generalization across settings.

Two caregiver-child dyads withdrew from the study after the T2 assessment and two withdrew after T3, resulting in an attrition rate of 50%. Similarly, studies with long-term follow-up report a 30% to 70% attrition rate (Miller & Wright, 1995; Tambs et al., 2009). Schaffer (1996) suggests that there is a high chance of participants dropping out of studies that have long-term maintenance periods. In the present study, it appears that attrition at T3 and T4 was not systematic, and rather, was due to factors specific to each family. For example, one caregiver-child dyad withdrew because they were offered a different service that was more suited to the child's needs, and three caregiver-child dyads withdrew due to ongoing illnesses, and related Covid-19 service restrictions. The high attrition rate makes it difficult to interpret the maintenance results as it is possible that there were different profiles of PECS users and

caregivers at T2 compared to T3 and T4. The present study incorporated several strategies known to support ongoing participation (i.e., involving community partners in study design, recruitment, and retention; providing reminders about upcoming appointments and study participation; Abshire et al., 2017). However, to better understand long-term outcomes, and minimize attrition, future studies should include the following strategies to attempt to maintain participants for the duration of the study: (a) designing systematic methods for participant contact; (b) appointment scheduling and cohort retention monitoring; (c) minimizing participant burden through characteristics and procedures of follow-up session requirements; (d) providing benefits to participants directly related to the study; and/or (e) providing financial incentives or payment, and reimbursement for research-related expenses, among others (Abshire et al., 2017).

Limitations and Strengths

Several limitations were present in the study. First, although this study expanded upon the results of Trezel et al. (2021) and included eight participants compared to one, the results from this study cannot be generalized to all children with ASD and their caregivers due to the small sample size and restrictive inclusion/exclusion criteria (e.g., children with significant challenging behaviour were excluded). Second, the absence of a control group limits our ability to make direct conclusions regarding the impact of the 1-week PECS camp on caregiver and child outcomes. It is unlikely that the results of the study are solely based on additional effects such as maturation; however, this cannot be specifically stated. Third, Hawthorne effect may have occurred as caregivers and children were aware that they were being observed and may have altered their behaviour as a result (Ledford & Gast, 2018). Further, there was a possible risk of bias as coders were not naïve to study conditions (Ledford & Gast, 2018). However, to reduce threats to internal validity, the IOA coder was naïve to study conditions and the purpose of the

study. Next, the daily data that was collected during camp was not reported. Therefore, we are unable to report the exact number of PECS trials conducted per day, the number of trials per PECS phase, or details related to children's performance during camp. The last notable limitation was that because the 1-week PECS camp involved both caregiver training and child teaching, we are unable to isolate the intervention components most responsible for child/caregiver progress.

This study also includes many strengths and contributes to the existing literature in several ways. First, no research studies have explored brief child and caregiver PECS interventions. The 1-week PECS camp involved only 7.5 hrs of caregiver training and 15 hrs of child teaching. Despite the brief nature of the camp, both caregivers and children improved from baseline. These results are unique and clinically meaningful as they suggest that the 1-week PECS camp may be both effective and resource efficient. To further enhance outcomes, additional supports may be necessary for some participants (e.g., booster sessions). Next, this study makes a unique contribution to the literature as there are currently no studies that explore both caregiver and child PECS generalization and maintenance. Notably, both caregivers and children generalized their teaching skills to the home after this brief teaching model. Although caregivers maintained their skills over time, children did not to the same extent. As described above, additional supports may be beneficial for some participants. Further, these findings expand the existing literature on BST plus GCT, as Treszl et al. (2021) is currently the only published study reported to use this model to teach caregivers to implement PECS. Last, reporting on caregiver treatment integrity is a unique contribution as much of the literature solely focuses on child outcomes, or does not directly measure caregiver treatment integrity (e.g., Carson et al., 2012; Greenberg et al., 2012).

Future Research

Future research should be conducted in specific areas. For example, with a total of eight participants from T1 to T2, the results of this study may not be generalizable. Future studies should investigate brief-PECS interventions with an increased number of participants. Additionally, some caregiver-child dyads withdrew at T3 and T4, and the PECS results of the remaining children were variable during maintenance assessments. It would be beneficial to explore new brief models that incorporate greater follow-up support (e.g., booster sessions, ongoing consultation; Hayward et al., 2009). This may mitigate attrition and support caregiver and child success. Incorporating greater follow-up support may also result in higher caregiver treatment integrity and caregiver adherence to the intervention. Notably, although this study makes important contributions to our understanding of caregiver PECS treatment integrity, we cannot say anything about adherence, or the use of PECS outside of the assessments (Allen & Warzak, 2000). Future studies should aim to investigate caregiver treatment adherence to gain a better understanding of how PECS is used in the natural environment, outside of the PECS assessments. Next, this study contributes to the literature on child PECS generalization to the home setting; however, additional research should investigate direct measures of child PECS generalization across communicative partners, stimuli, and additional settings. In addition, given the objectives of this study, and nature of the project, a pre-post design was appropriate. However, future studies should include a research method that allows for greater experimental control. Finally, as demonstrated throughout the study, some children did not make substantial gains (e.g., participant 8). Future research exploring child characteristics and PECS outcomes would be beneficial to better align services with individual needs. It is possible that brief models of intervention may be effective for some children and families but may be insufficient for others.

Conclusion

Overall, the results of this study provide emerging evidence that a brief 1-week PECS camp may be an efficient and effective method of teaching caregivers and children initial PECS skills. Following the implementation of the camp, average caregiver treatment integrity across all phases of PECS improved and maintained from T2 to T4. However, caregivers made more substantial gains in phases 1 and 2 compared to 3a and 3b. In addition, the skills caregivers learned in the training setting generalized to the home setting and this generalized behaviour change persisted during maintenance assessments. Similarly, children's PECS use improved after the implementation of the 1-week PECS camp and generalized to the home setting. However, child PECS maintenance was variable throughout the phases. It is important to note that the broad range of average caregiver and child PECS skills throughout all phases and timepoints, suggests substantial individual variability. These results indicate this brief PECS model may be beneficial for some caregivers and children; however, it may not be sufficient for all.

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Appendix A

Description of PECS Phases

Phases	What is taught	Description
1	Requesting via picture exchange	PECS users are taught to pick up a picture of a preferred item/activity and place the picture in their communication partner's hand (i.e., "exchange" the picture). Once the picture is released, the PECS user is immediately given the item.
2	Distance and persistence	PECS users are taught to travel to their communication binder and to their communicative partner in order to build more persistent communication skills.
3a	Simple picture discrimination	PECS users are initially taught to discriminate between preferred and non-preferred pictures using behavioural approaches to discrimination training.
3b	Complex picture discrimination	PECS users are taught to choose between pictures of multiple preferred items and/or to look in their book to select pictures. The child will exchange the picture and select the corresponding item in a correspondence check.
4	Requesting with the phrase "I want ____"	PECS users are taught to construct complete sentences, i.e., "I want ____". First, they are prompted to add the picture depicting "I want" to the left-hand side of a sentence strip, then add the picture of the desired object to the right-hand side of the sentence strip. The entire sentence is then exchanged.
5	Answering "What do you want?"	PECS users are taught to request items in response to the question, "What do you want?"
6	Commenting	PECS users are taught to use pictures to label or comment on objects and events. Various sentences may be taught, including commenting on items/activities of interest, responding to questions in social/academic contexts, etc.

Note. Adapted from Koudys et al. (2021).

Appendix B

PECS Teaching Procedures

Phase	Teaching procedures
1	The communicative partner will entice the child with a highly preferred item, wait for the child to indicate interest in the item/begin the exchange, open their hand to receive the picture, reinforce the child's picture exchange within half of a second, and label the item and deliver social praise along with the reinforcer. If the child makes an error, the back-step error correction procedure will be conducted.
2	The communicative partner will set the binder up a specified distance away from the child, locate themselves a specified distance away from the binder, entice the child with the highly preferred item, and deliver the reinforcer to the child for travelling to exchange the picture. If the child makes an error, the back-step error correction procedure will be conducted.
3a	The communicative partner will place a distractor and highly preferred picture on the binder, entice the child with the highly preferred item and the distractor/non-preferred item, and deliver the item corresponding with the exchanged picture. If the child exchanges the picture of the desired item, the child will receive the desired item. If the child exchanges the distractor/non-preferred picture, the child will receive the distractor/non-preferred item. The four-step error correction procedure will then be used to teach the child to request using the appropriate picture.
3b	The communicative partner will have minimum two preferred items under their control, will place the corresponding pictures on the front of the binder, entice the child with the items, and conduct a correspondence check. If the child selects the item corresponding to the picture they exchanged, the child will receive the item (i.e., reinforcer). If the child attempts to access the item that does not correspond with the picture exchanged, the four-step error correction procedure will be used to teach the child to request the desired item using the appropriate picture.

Note. Adapted from the 2nd Edition PECS[®] Training Manual (Frost & Bondy, 2002).

Appendix C

Caregiver Demographic Form

PECSperts! Camp

1. Name: _____
2. Age: _____
3. Ethnicity: _____
4. First language: _____
5. Other languages spoken/read: _____
6. Marital status: _____
7. Highest level of education achieved: _____
8. If you attended college or university – what was the focus of your studies (e.g., degree/ diploma type): _____

9. Do you work outside the home? _____
10. If yes, what is your job? _____
11. If yes, do you work part-time, full-time, casual employment? _____

Appendix D

Caregiver Treatment Integrity Checklist

Mediator		Participant (initials)	
Date of session			<input type="radio"/> Alone <input type="radio"/> Second person present
Time of session		Session duration	

Phase 1 Skills	Trials									
	1	2	3	4	5	6	7	8	9	10
Communication Partner										
1. Arranges the environment effectively for Phase 1										
- Multiple possible preferred items and/or activities available - Environment is generally clear of other easily accessible putative reinforcers										
2. Identifies child's current preference										
- Looks to see what items or activities the child is interested in - May give a "freebie" of the item to confirm child is interested										
3. Sets up communication opportunity at Phase 1										
- Attempts to maintain control of items/activities - Single picture in front of child - Positioned across from the child with the item in their control										
4. Silently entices										
- Shows the child the preferred item or activity - Does not verbally entice the child										
5. Uses open hand effectively										
- Opens hand to receive picture only after the child has initiated towards the item or the picture										
Uses Back Prompter Effectively										
6. Uses back prompter effectively										
- Waits for the back prompter to prompt the child to pick-up, reach, release when child reaches for the item or picture - Requests back prompter assistance to prompt the child to pick-up, reach, release										
Responds to a Correct Exchange										
7. Accepts the picture										
- Receives picture in open hand										
8. Delivers the reinforcer in a ½ second										
- Delivers the item or activity to the child immediately										
9. Vocally labels the item										
- May or may not deliver praise, but only after the vocal model										
Responds to an Error by Restarting the Trial										
10. Places the picture back down in front of the child										
11. Silently re-entices										
- Shows the child the preferred item or activity - Does not verbally entice the child										
Back-Prompter										

Appendix E

Social Validity Questionnaire

TREATMENT ACCEPTABILITY RATING FORM—REVISED (TARF-R)

Please complete the items listed below. The items should be completed by placing a check mark on the line under the question that best indicates how you feel about the Picture Exchange Communication System® (PECS®) training you participated in.

The first questions are about your experience learning to teach PECS.

1. How clear was your understanding of PECS following the hands-on coaching (behavioural skills training)?

Not at all clear

 Neutral

 Very clear

2. How well did you think you could implement PECS following the hands-on coaching (behavioural skills training)?

Not well

 Neutral

 Very well

3. How well did you think you could implement PECS following the 1-week camp?

Not well

 Neutral

 Very well

4. OVERALL, how acceptable did you find the PECS training and coaching that you received?

Not at all Acceptable

 Neutral

 Very acceptable

The next questions are about your experience teaching your child to use PECS.

5. How acceptable did you find PECS for your child?

Not at all Acceptable

 Neutral

 Very acceptable

6. How willing were you to carry out PECS teaching with your child?

Not at all Willing

 Neutral

 Very willing

7. Given your child's needs, how reasonable did you find PECS?

Not at all Reasonable

 Neutral

 Very reasonable

8. To what extent did you think there were disadvantages in teaching PECS?

Not at all Likely

 Neutral

 Many are likely

9. How likely is this treatment to make ongoing improvements in your child's communication skills?

Unlikely Neutral Very likely

10. To what degree were your child's communication difficulties of concern to you?

No concern at all Neutral Great concern

11. How confident were you that PECS would be effective?

Not at all confident Neutral Very confident

12. How effective did you think PECS was for your child?

Not at all effective Neutral Very effective

13. How much did you like the teaching procedures used in PECS?

Did not like them at all Neutral Liked them very much

14. How willing were other family members to help carry out PECS? (Circle **NA** if not applicable)

Not at all willing Neutral Very willing

15. To what extent did undesirable side-effects result from PECS?

No side-effects Neutral Many side-effects

16. How much discomfort (if any) did your child experience during the course of camp?

No discomfort at all Neutral Very much discomfort

17. How severe were your child's communication difficulties?

Not at all severe Neutral Very severe

18. How willing are you to continue to support your child's PECS use? (Circle **NA** if not applicable)

Not at all willing Neutral Very willing

19. How willing are you to change your family routine to carry out PECS? (Circle **NA** if not applicable)

Not at all willing Neutral Very willing

20. How well do you think PECS will fit into your family routine? (Circle **NA** if not applicable)

_____ Not at all

_____ Neutral

_____ Very well

21. What was most helpful or your most preferred aspect of the PECS camp training package?

22. What was least helpful or your least preferred aspect of the PECS camp training package?

Appendix F

Phase 1 Instructional Universe

Caregiver Behaviour	Child Behaviour							
	Correct–picks up picture, reaches, releases with prompts	Correct–picks up picture, reaches, releases without prompts	Correct–moves around to access different items/ activities	Correct–looks at item but does not reach for item or picture	Correct–reaches for another item in the environment	Correct–does not demonstrate interest in any items	Correct–physical prompting ineffective	Incorrect–puts picture in mouth, drops it, or plays with it
Delivers R+, labels item	SC1							
Delivers R+, labels item, provides extra time for Ind exchange		SC2						
Conducts PECS on-the-run			SC3					
Entices with item and/or conducts new preference assessment				SC4				
Uses different item in environment that child reaches for					SC5			
Offers freebie or another item or goes to different location with new items						SC6		
Sets up environment to make less prompting necessary							SC7	
Conducts error correction by removing picture, placing it back down, and re-enticing								SC8
	Reinforcer Variations							
	Consumables (e.g., edibles, bubbles)	Stationary items (e.g., car ramp)	Activities (e.g., slide, swing)	Small items (e.g., small car)	Large items (e.g., yoga ball)	Consumables (e.g., edibles, bubbles)	Non-consumables (e.g., toys)	Movable items (e.g., wagon)
	Binder Variations							
	N/A for phase 1							

Appendix G

Phase 1 Scenario List

Scenario	Response
Communicative Partner Scenarios	
<p>Scenario 1 Your child exchanges a picture with the help of a back-prompter. After they place the picture in your hand, how would you complete this trial? <u>Show us how you would set up the environment and communication opportunity, and how you would respond to your child.</u> *Consumable item (e.g., edibles, bubbles)</p>	<p>Caregiver arranges the environment effectively (i.e. maintains control of reinforcers and has multiple available). Sets up the opportunity correctly (i.e. places one picture in front of the child) and silently entices. Upon receipt of the picture, immediately deliver the item to the child and verbally label the item.</p>
<p>Scenario 2 Your child exchanges a picture without the help of a back-prompter. After they place the picture in your hand, how would you complete this trial? <u>Show us how you would set up the environment and communication opportunity, and how you would respond to your child.</u> *Stationary item (e.g., car ramp)</p>	<p>Caregiver arranges the environment effectively (i.e. maintains control of reinforcers and has multiple available). Sets up the opportunity correctly (i.e. places one picture in front of the child) and silently entices. Upon receipt of the picture, immediately deliver the item to the child and verbally label the item. Provide extra time or more of the item because your child exchanged independently.</p>
<p>Scenario 3 Your child will not sit at a table or stay in the same spot on the floor, making it difficult to set up a communication opportunity. They are interested in different things in the environment and are often moving around to play with them. Show us how you would set up the environment and communication opportunity, and how you would respond to your child. *Activities (e.g., slide, swing)</p>	<p>If you can identify an item that they are moving toward (e.g., going toward a bean bag to flop in, a bed to jump on), use that for training. It might help to clear the environment of other preferred items to help your child focus. Then set up the communication opportunity where their preferred items or activities are located in the moment.</p>
<p>Scenario 4 Your child is looking at the item/activity offered but does not reach for the item or picture. Show us how you would complete this trial? *Small item (e.g., small car)</p>	<p>Entice with the item (i.e., model function of the toy, eat a piece of the food item in your possession, etc). If the child does not show interest in the item, offer other items to conduct a new preference assessment. Once you have identified your child's interest re-run trial with the new item.</p>
<p>Scenario 5 You set up a communication opportunity with something you think your child wants. They do not demonstrate interest/reach for the item. But they do reach for another item in the environment. Show us how you would complete this trial? *Large item (e.g., yoga ball)</p>	<p>Allow your child brief access to the other item to evaluate their interest (e.g., give a freebie). If the child demonstrates interest/engages with the item, use the newly identified reinforcer to set-up the communication opportunity.</p>
<p>Scenario 6 You have repeatedly enticed your child with at least 3 items they usually like. But they do not demonstrate interest in any of the offered items. Show us how you would complete this trial? *Consumable item (e.g., edibles, bubbles)</p>	<p>Pause and find out what your child is interested in You can offer a "freebie" (e.g., bite of food, brief access to toy), offer other items, or take them to different areas in your house/outside. Once you have identified what your child likes, gain control of that item/activity and set up the communication opportunity with it.</p>
<p>Scenario 7 While working with your child, they seem bothered by physical prompting and try to resist prompts from the back prompter. Show us how you would complete this trial? *Non-consumable item (e.g., toys)</p>	<p>Change the set-up/environment to make less prompting necessary. For example, you can move the picture closer to the preferred item so when they reach for the item it is easier for the back-prompter to help them pick-up and exchange the picture. The communication partner can also bring their hand closer to the picture to reduce prompting.</p>
<p>Scenario 8 Your child picks up the picture and puts it in their mouth or drops it on the ground or starts to play with it. Show us how you would complete this trial? *Movable items (e.g., wagon)</p>	<p>Restart the trial. Remove the picture and place it back in front of your child, re-entice with the same or a more preferred item.</p>

Appendix H

Error Correction Procedures

Phases	Error Correction Procedure	Description
1/2	Backstep error correction	The physical prompter takes the student back in the sequence to the last step completed correctly and then provides extra assistance to complete the sequence correctly.
3a	4-Step error correction: Highly preferred versus distractor	The communicative partner entices with both items, student gives incorrect picture, communicative partner gives corresponding item, student reacts negatively. The communicative partner then shows or taps the target picture (gets student to look at the target picture on the book). Next, the communicative partner holds open hand near target picture, physically, or gesturally prompts; the student gives the target picture, and the communicative partner labels item (but does not give item). The communicative partner asks student to do switch task and the student performs the switch task. Finally, the communicative partner entices with both items, the student gives correct picture, and the communicative partner gives item, labels it and gives praise.
3b	4-Step error correction: Correspondence check	The communicative partner entices with both items, the student gives picture, the communicative partner says “take it,” the student reaches for the item that does not match the picture; the communicative partner blocks access. The communicative partner then points or taps the correct picture (gets student to look at the correct picture on the book). Next, the communicative partner holds their hand open near target picture or physically or gesturally prompts. The student gives target picture, and the communicative partner labels item (but does not give item). The communicative partner asks student to do switch task and the student performs the switch task. Finally, the communicative partner entices with both items, the student gives picture, communicative partner says “Go ahead,” student takes correct item, and communicative partner allows access, labels and provides praise.

Note. Adapted from the 2nd Edition PECS[®] Training Manual (Frost & Bondy, 2002).

Appendix I

Camp Schedule

Time	Monday-Friday
9:00am	Group 1 Child Camp
10:30am	Group 1 Child Camp & Caregiver Training Part 1
11:30am	Group 1 Caregiver Training Part 2 (Caregiver-child coaching)
12:00pm	Group 1 Caregiver & Child go home
1:00pm	Group 2 Child Camp
2:30pm	Group 2 Child Camp & Caregiver Training Part 1
3:30pm	Group 2 Caregiver Training Part 2 (Caregiver-child coaching)
4:00pm	Group 2 Caregiver & Child go home

Note. Primer videos were played on day 1, phase 1 was taught on day 2, phase 2 on day 3, phase 3a on day 4, and phase 3b on day 5.

Appendix K

Caregiver Coaching Procedural Fidelity Checklist

Caregiver Trainer	Caregiver Participant Code							
Skills	Caregiver-Child Coaching Sessions							
	1	2	3	4	5	6	7	8
	Date:	Date:	Date:	Date:	Date:	Date:	Date:	Date:
	Phase 1	Phase 1	Phase 2	Phase 2	Phase 3a	Phase 3a	Phase 3b	Phase 3b
1. Caregiver trainer will ask mediator to briefly describe how the child is performing with PECS (e.g., reinforcers, independence, prompts).								
2. Caregiver trainer will ask caregivers if they are comfortable with the suggestions received.								
3. Caregiver trainer will explain the nature and sequence of events in the caregiver coaching session, including the caregiver's role.								
4. Caregiver trainer will ask mediator to conduct a few PECS trials as a model for the caregiver.								
5. Caregiver trainer will ask the caregiver to practice a few trials of the PECS phase taught that day with their child.								
6. Caregiver trainer will provide in the moment prompting to support caregiver success.								
7. Caregiver trainer will provide positive or corrective feedback.								
8. Caregiver trainer will record whether the trial was Independent or Prompted								
Total Correct								
Percent Correct								
Total Percent Correct in Caregiver Coaching Sessions								

*To have procedural fidelity data on 30% of caregiver coaching sessions, 2-3 sessions should be observed.