PECSPERTS: EVALUATING TELEHEALTH AND HYBRID CAREGIVER TRAINING MODELS FOR TEACHING CAREGIVERS HOW TO IMPLEMENT THE PICTURE EXCHANGE COMMUNICATION SYSTEM

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Abstract

Roughly 30% of children diagnosed with autism do not develop functional speech. For these children, augmentative and alternative communication systems (AAC) may be used to help develop functional communication systems. One such system is the Picture Exchange Communication System (PECS). Prior research has established professional-delivered PECS as an evidence-based AAC. However, few studies have assessed the efficacy of parent training on caregiver PECS use and there is limited research on the use of telehealth technology when implementing PECS caregiver training. Further, there is limited research around child characteristics such as cognitive level, adaptive functioning, and pre-requisite skill level and their relations to PECS outcomes. This dissertation reports on two studies designed to expand our understanding of PECS caregiver training using both telehealth and in-person applications of behavioural skills training (BST) and generalized case training (GCT).

Study one evaluated the feasibility as well as caregiver outcomes of a telehealth caregiver training model, hereafter described as the PECSperts Caregiver Training package. Six caregivers participated in a two-week telehealth training in which they were taught how to implement the first four phases of PECS (phases 1-3b) using BST and GCT. Caregivers were taught to implement PECS with the use of structured scenarios and demonstrated their skill through roleplay with a trained mediator. Following the conclusion of the 2-week training, all caregivers had met the mastery criteria for all four phases. Further, caregivers maintained these treatment gains at 1- and 3-month follow-up assessments.

Study two evaluated a second iteration of the PECSperts Caregiver Training package and included an evaluation of child outcomes, as well as child characteristics (e.g., cognitive level and adaptive functioning) and their relations to child PECS outcomes. Nine caregivers participated in a 4-week hybrid training which included both telehealth and in-person components. Participants were evaluated on their ability to implement the first four phases of PECS (phases 1-3b) with their children and their children were evaluated on their independent PECS use across five timepoints. Overall, there was a significant improvement in both caregiver PECS teaching accuracy and child PECS use accuracy between baseline and the end of intervention. Further, caregivers and children maintained their treatment gains at both 1- and 3-month follow-up. Baseline child characteristics were not significantly associated with PECS outcomes at the end of the intervention; however, parents reported a significant decline in autism symptom severity over the course of the intervention.

This dissertation addresses several gaps in the literature and provides preliminary support for the PECSperts Caregiver Training package. Across both studies, caregivers improved in their ability to implement the first four phases of PECS following a brief intervention. In study two, children also demonstrated improvements in their ability to use PECS following a brief intervention. Additionally, both studies reported successful applications of telehealth technology in autism service delivery. Both limitations of and future directions for the PECSperts Caregiver Training package are discussed.

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Table of Contents

***Note*:** Appendices have been redacted from the published version of this dissertation as these materials belong to a larger program of research which has not yet been published

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Definition
AAC	Augmentative and Alternative Communication
ABA	Applied Behaviour Analysis
ABAS	Adaptive Behaviour Assessment System
AIM	Autism Impact Measure
ASD	Autism Spectrum Disorder
BCBA	Board Certified Behaviour Analyst
BCBA-D	Board Certified Behaviour Analyst - Doctoral
BST	Behvioural Skills Training
CARS	Childhood Autism Rating Scale
EBP	Evidence-based practice
EIBI	Early Intensive Behavioural Intervention
GCT	General Case Training
ID	Intellectual Disability
IOA	Interobserver Agreement
MSEL	Mullen Scales of Early Learning
OAP	Ontario Autism Program
PECS	Picture Exchange Communication System
PRT	Pivotal Response Treatment
SSRD	Single Subject Research Design
TARF-R	Treatment Acceptability Rating Form–Revised

Chapter 1: Introduction

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is generally diagnosed in early childhood (American Psychiatric Association, 2013). Children who receive a diagnosis of ASD display impairments in two domains of function: social communication and repetitive and restrictive behaviours and interests (American Psychiatric Association, 2013). These impairments must have been present during early childhood and they must cause significant impairment in the individual's day to day life. Social-communicative impairments are a hallmark of the ASD diagnosis and, as such, significant attention has been devoted to better understanding these impairments from epidemiological and clinical perspectives. The social-communicative deficits displayed by children diagnosed with ASD are numerous and include poor eye contact, deficient joint attention and social orienting, the inability to perceive emotions in peers and others in their environment, limited theory of mind, failure to imitate behavioural models of both adults and peers, and restricted ability to engage in associative, cooperative, and symbolic play (Cicchetti, 2016; Dawson et al., 2004). As basic social skills are generally a prerequisite to more complex adaptive living skills and to the ability to learn rapidly in one's environment, such symptoms may result in negative outcomes for children. Many autistic children (up to 70% of diagnosed ASD cases) are also diagnosed with a co-occurring intellectual disability (ID), with a recent systematic review indicating a median rate of co-occurrence of 33% (Zeidan et al., 2022). This comorbidity further complicates the prognostic picture for autistic children (Matson & Shoemaker, 2009; Postorino et al., 2016).

Language impairments also quite common for autistic children. While many autistic children develop speech, around 25 - 30% never develop any spoken language (Flippin et al., 2010; Tager-Flusberg & Kasari, 2013). For those who do develop speech, echolalia, pronoun reversal, and receptive language tend to be areas of difficulty and can compromise an individual's ability to use language functionally (Boucher, 2003; Gernsbacher et al., 2016). For those who do not develop speech, alternative and augmentative communication systems (AAC; Syriopoulou-Delli & Eleni, 2022) may be helpful. These systems utilize various communicative methodologies to teach functional communication that can either replace speech, if it does not develop, or act as a bridge to functional speech if it does indeed develop. Various systems and procedures have been used and have included various ways of using pictures, manual sign language, and speech-generating devices (Ganz et al., 2012).

The Picture Exchange Communication System

Among the available AAC systems, The Picture Exchange Communication System (PECS) is one of the most common and best studied. Based on the principles of applied behaviour analysis (ABA), PECS utilizes a six-phase approach (see Table 1) to teach increasingly complex functional communication (Bondy & Frost, 1994). As children progress through the system, their communication is shaped from exchanging one picture for a desired item to spontaneously commenting on their surroundings. Throughout the training protocol, learners are taught in a discrete trial format within the naturalistic environment. A structured error correction and prompting protocol are utilized through every phase (Bondy & Frost, 1994). Further, decisions to progress to new phases in the system are based on objective criteria and data which are collected during each communicative trial. Clinicians implementing PECS should ideally be properly trained and supervised, as well as assessed on their treatment fidelity at regular intervals.

Table 1

Phases of PECS

Phase	Description of Phase
1: How to Communicate	Individual is taught how to exchange one picture for a reinforcer
2: Distance and Persistence	Individual is taught to exchange pictures when the communicative partner is some distance away from the picture binder
3a: Picture Discrimination	Individual is taught how to discriminate between a preferred and non-preferred item / stimuli
3b: Picture Discrimination	Individual is taught how to discriminate between two preferred items / stimuli
4: Sentence Structure	Individual is taught how to construct a sentence with pictures, including the use of the “I want” picture
5: Responsive Requesting	Individual is taught to use their pictures to communicate when asked “What do you want?”
6: Commenting	Individual is taught to answer questions such as “what do you see?” which results in social, rather than tangible reinforcers. Individual is also encouraged to spontaneously comment on their surroundings.

Note: Adapted from Bondy and Frost (1994) and Frost and Bondy (2002)

The development of PECS was notable in that Bondy (a behaviour analyst), and Frost (a speech-language pathologist) (1994) indicated that children learning the system did not require any of the prerequisite skills which were assumed to be associated with success in other communicative methodologies. More specifically, they indicated that children could learn to use PECS without previously demonstrating eye contact and attending, imitation (verbal or motor), or the ability to match to sample.

Over the years, much research has been conducted on PECS, providing evidence of its efficacy. Research methods have included single-case research designs and group-design studies, which is important for determining the evidence base for intervention methodology. Much of the behaviour analytic research base has relied on and continues to rely on single-case research designs (SCRD) which involves a participant acting as their own control. Specifically, the participant is systematically exposed to both a baseline and intervention condition, and a behaviour of interest is measured repeatedly through all conditions. Single-case research designs allow for in-depth understandings of individual-level response to an intervention, as well as demonstration of a functional relationship between an intervention and a behaviour of interest; however, the generalizability of their findings is limited (Byiers et al., 2012; Cooper et al., 2020). Group-design methodology, while common in psychology overall, constitutes a minority of research designs used in behaviour analytic research (Rader et al., 2021). Group-design research differs from SCRD in that larger groups of participants are generally randomized or assigned to different conditions (i.e. control and intervention) and individual level results and variation are rarely assessed. Outcomes are then compared across conditions rather than comparing an individual's outcomes against their baseline. Group-design research has more robust generalizability due to the larger sample sizes. This is an important advantage, as generalizability is essential when assessing intervention methodology (Rader et al., 2021).

A review by Preston and Carter (2009) concluded that, based on the 27 studies, PECS, when implemented by professionals in clinic environments, is easily accessible to learners and is generally successful in teaching functional communication skills. These results were based on an analysis of both SCRD and group designs, including randomized control trials. At that time, data on problem behaviour and speech generation was limited and thus conclusions could not be drawn about these specific outcomes. These conclusions were corroborated by a meta-analysis by Flippin et al. (2010), who concluded that PECS is associated with moderate gains in communicative ability (e.g., greater frequency of picture exchanges, greater number of spontaneous requests; as evidenced by a mean weighted effect size of 0.51 for single-case research). Further, results around speech production were inconsistent, with some studies reporting that some participants went on to produce vocal speech and others reporting that none of their participants developed speech while using PECS. There was an absence of generalization and maintenance data available. Flippin et al. (2010) also discussed potential child characteristics which may predict or moderate success with PECS. Although the research is limited, they highlighted that joint attention, object exploration, and imitation are potential variables associated with success.

More recently, research has examined how PECS performs compared to other AAC systems, including those which utilize technology. In a meta-analysis of single-subject AAC research, Ganz et al. (2012) found that PECS had similar effect sizes to speech generating devices (SGD) but outperformed non-PECS picture-based systems. Boesch et al. (2013) evaluated the efficacy of PECS compared to an SGD for three children diagnosed with autism. They found that there was no meaningful difference in the number of communicative attempts a child made according to whether they were utilizing PECS or an SGD. They hypothesized that phase 2 of PECS is associated with increased social communication, given the requirement of the child to purposefully initiate an interaction with a communicative partner across a large space. Similarly, Couper et al. (2014) found that there tended to be no meaningful differences in ability to learn PECS, manual sign, or a speech generating device when they taught all three systems to seven children with Autism. Given the structured and behaviourally oriented approach PECS takes to the teaching process, it has been adopted in many behaviour-analytic intervention programs, including comprehensive Early Intensive Behavioural Intervention (EIBI) programs for children with Autism.

The Ontario Autism Program

Over the past five years, the Ontario Autism Program (OAP) has been in a state of flux. In prior years, children with autism who were on the severe end of the spectrum would access EIBI following an initial intake assessment with one of the Ontario regional providers, depending on their geographic location (Ontario Ministry of Child and Youth Services, 2006). Upon admission to EIBI, children would generally receive services for 20 or more hours per week, for a minimum of six months (Piccininni et al., 2017). While in these programs, children received comprehensive intervention targeting a variety of developmental areas, with the intent of improving skills, reducing problem behaviour, and improving child quality of life (Perry, 2002). This EIBI model of service delivery in Ontario was well-studied, and had considerable support for its effectiveness (e.g., Flanagan et al., 2012; Freeman & Perry, 2010; Perry et al., 2008). Specifically, children who received EIBI in this prior model tended to experience improvements in cognitive function, adaptive function, and autism symptom severity (Flanagan et al., 2012). Access to EIBI in Ontario required a confirmed diagnosis of autism by a qualified physician, psychologist, or psychological associate. High demand for these services, as well as increased eligibility, resulted in extensive wait lists, with a mean wait time of 2.7 years, and some children waiting up to four years (Piccininni et al., 2017). Prior research had demonstrated diminishing intervention benefits as children got older, making these delays particularly detrimental (Blacklock et al., 2014; Perry et al., 2013). Extensive diagnostic and intervention waitlists in Ontario resulted in children entering intervention at a later age, with suboptimal clinical outcomes (Piccininni & Penner, 2016).

In 2019, the newly elected Progressive Conservative government of Ontario announced a major change to the OAP, essentially ending the delivery of EIBI in Ontario. Specifically, they proposed a system in which caregivers of children with autism received intervention funds directly, rather than receiving the choice of free direct service from a regional provider or funds to purchase services privately. At this time, children could receive a maximum of $140,000 over their lifetime in the program if admitted at the age of 2 ($17,000 per year from ages 2 to 6, and $5,000 per year until age 18), and a maximum of $55,000 (i.e. $5,000 per year) if they were admitted at the age of 7 (Government of Ontario, 2019). Following considerable protest from caregivers and the public at large, the government developed the Ontario Autism Program Advisory Panel to provide recommendations on the development of a needs-based autism program (Government of Ontario, 2019). After convening over the course of 5 months, the panel delivered a report recommending the implementation of a needs-based autism program which included behaviour analytic services, mental health services, early intervention, urgent response capabilities for families in need, and a variety of other supports and services (Ontario Autism Program Advisory Panel, 2019). At this time, the government implemented several of the recommendations made in this report, which led to the development of the current OAP. Under this new model, families and individuals can access five different service streams including: foundational family services, caregiver-mediated early years programs, core clinical services, entry to school program, and urgent response services. Within this new framework, families undergo a needs assessment with an intake coordinator and are provided with a direct funding package (i.e. families receive the funds directly into their bank account) from which to purchase approved core clinical services (e.g., ABA, mental health services, speech-language therapy, occupational therapy). Foundational services (e.g. clinic visits, caregiver workshops), caregiver mediated early years programs, entry to school, and urgent response services are offered free of charge (Government of Ontario, 2023). Despite these changes, the waitlist for these services has quickly ballooned, with more than 60,000 autistic children and adolescents waiting for OAP funding to purchase core clinical services.

Under the new OAP model, caregiver involvement has become a large area of focus, especially with the caregiver-mediated early years programs. In Ontario, these programs are offered to families who have a child between the ages of 12 and 48 months and who are currently registered with the OAP (i.e., have a confirmed autism diagnosis) and are offered for up to 6 months. Once enrolled in the OAP, caregivers have the choice of participating in one of six caregiver mediated early years program (depending on what is offered by their local service provider; Government of Ontario, 2023). The current offerings in the province include: Early social interaction / social communication emotional regulation and transactional supports (ESI/SCERTS; Yi et al., 2022), Joint attention, symbolic play, engagement, and regulation (JASPER; Waddington et al., 2021), Pivotal Response Treatment (PRT; Ona et al., 2020; Verschuur et al., 2014), Play and Language for Autistic Youngsters (PLAY) project (Solomon et al., 2007; Solomon et al., 2014), Project ImPACT (Stadnick et al., 2015; Stahmer et al., 2020) , and Social ABCs (Brian et al. 2016; Brian et al., 2017). The goal of these caregiver-mediated early years programs is to train caregivers to implement programming with their child to teach skills in the following areas: social interaction, play, communication, emotion expression, and self-help (Government of Ontario, 2023). While the theoretical orientation and approach of these models (e.g., behavioural, developmental) vary, each focuses on improving a child’s ability to communicate their needs effectively. Importantly, the models used in the OAP focus primarily on the development of vocal speech and the use of AAC is not explicitly taught or programmed for in many of these models. This feature is troubling, given that up to 30% of children with autism may never develop functional speech (Tager-Flusberg & Kasari, 2013). Given that these caregiver mediated early years programs are some of the most available publicly funded services, there is a clear need for an analogous caregiver-mediated intervention for young children who do not have functional speech or who have emerging communicative repertoires and who would benefit from access to PECS.

Evidence-Based Practice in Psychology and Autism Spectrum Disorder

Evidence-based practice (EBP) in psychology is defined as "the integration of the best available research with clinical expertise in the context of patient characteristics, culture, and preferences" (American Psychological Association, 2006). Much debate has occurred on what constitutes sufficient research evidence, leading to the development of guidelines to inform the assessment of interventions in autism treatment. The National Professional Development Centre on autism spectrum disorder (Wong et al., 2015) identified evidence-based practice as any practice which has garnered two well-designed randomized or quasi-experimental design studies, or five single-case design studies, or a combination of one randomized or quasi-experimental design plus three single-case design studies demonstrating efficacy of the intervention. Similarly, the National Clearinghouse on Autism Evidence and Practice (Hume et al., 2021) and the National Autism Centre (2009, 2015) utilized the same algorithm to identify evidence-based practices.

Evidence-based practice is an essential component of psychological and behaviour analytic practice in general and has become increasingly prominent within the realm of autism service provision. Historically, there has been a great deal of interest in intervention for autism which has resulted in the development of interventions ranging from helpful to ineffective, and at times, harmful (Hume et al., 2021). The most recent EBP review for intervention in autism identified a variety of interventions meeting the above-mentioned criteria. Many of the interventions listed as EBP fall under the behaviour analytic umbrella (e.g., reinforcement, prompting, task analysis). This review also assessed a variety of manualized interventions in ASD, including some of the early caregiver-mediated early years program offered in the OAP. Of the manualized interventions which were assessed, JASPER, PRT, and Project ImPACT met criteria to be considered EBP, however, the PLAY project, ESI/CERTS, and social ABCs were not identified. Of note, AAC, and PECS more specifically, is considered an established EBP, however caregiver delivered (via a mediator model) PECS has not received sufficient support to be classified as such (Hume et al., 2021; National Autism Centre, 2015; Wong et al., 2015). Along with these EBPs, over one thousand additional treatments have been marketed as intervention for autism, without any empirical support for their use (Paynter et al., 2020). Further, misconception around the evidence-base of a practice has been associated with higher use of unsupported intervention and lower use of EBP (Paynter et al., 2018). Given the pervasiveness of "fad" and unsupported autism interventions, it is essential that new and emerging treatment methods demonstrate effectiveness prior to their use and dissemination. This is especially true for services which are provided with the use of public funds, and which require significant caregiver involvement.

Focus of Dissertation

The following two studies introduce a caregiver-mediated intervention model for young children with autism and other developmental disabilities who do not currently have a functional communication system. The first study introduces a structured caregiver training package to teach parents to implement PECS using telehealth. This was the first iteration of the *PECSperts Caregiver Training Package* which was evaluated with a single-case research design. It provides data demonstrating the package's feasibility and its effects on caregiver PECS teaching accuracy. The second study introduces an evolution of this package which includes both telehealth and in-person components, evaluated with a group-based research design. Additionally, it includes an assessment of child PECS outcomes, as well as child characteristics (i.e., intellectual and adaptive functioning and autism symptom severity) to determine their correlation with PECS success. These two studies address gaps in both the existing literature around PECS and clinical practice in Ontario. Specifically, they evaluate the use of telehealth and hybrid training approaches in caregiver PECS training and begin to evaluate an early caregiver-mediated intervention model ideal for children who do not have functional vocal communication. It is hoped that these two studies, while filling important gaps in the literature, will also catalyze further evaluation of this caregiver-mediated intervention model, which could be offered to caregivers as part of publicly-funded OAP services.

Chapter 2: Evaluation of a Brief Telehealth Caregiver Training to Teach Implementation of the Picture Exchange Communication System

Introduction

Speech typically develops over the first few years of life. For those diagnosed with autism spectrum disorder (ASD), approximately 30% do not develop any functional speech (Tager-Flusberg & Kasari, 2013). In such cases, alternative and augmentative communication (AAC) systems may be recommended to help people communicate. One such AAC system that has proven to be effective for autistic individuals is the Picture Exchange Communication System (PECS®; Bondy & Frost, 1994).

The Picture Exchange Communication System is an evidence-based AAC often used with autistic children and youth who do not have functional vocal communication (e.g., Hume et al., 2021; Wong et al., 2015). Outcomes of various research into PECS has demonstrated that use of the system is associated with the development of an effective requesting repertoire (e.g., Adkins & Axelrod, 2002; Koudys et al., 2021) and rapid acquisition of skills related to specific PECS phases (e.g., requesting; Bock et al., 2005; Wang et al., 2021). Further, research has indicated that PECS use may be associated with improvements in social communicative behaviour (e.g., cooperative play, joint attention; Charlop-Christy et al., 2002), developmentally appropriate play skills (e.g., Jurgens et al., 2009), and increased communicative initiations directed towards teachers (Carr & Felce, 2007). In a review of the evidence, Tien (2008) evaluated the communicative outcomes of PECS in 13 studies and found that PECS was associated with overall improvements in communication which included greater spontaneous language, speech, imitation, initiations in communication, and mean utterance length. Further, a meta-analysis conducted by Ganz et al. (2012) noted the PECS is most effective at improving functional communicative outcomes (i.e., communicative initiation, requesting), but also noted that there are a variety of improvements in “non-targeted” outcomes which are associated with PECS use. More specifically, significant reductions in challenging behaviour and improvements in social behaviours and speech were noted as corollary effects of teaching PECS. It should be noted, however, that effect sizes were largest for functional communication, and smaller for non-targeted behaviours.

When using PECS, learners are taught communication skills within a naturalistic social context. The PECS protocol consists of six phases: (1) exchanging a picture, (2) exchanging a picture across a distance and persisting with communication, (3) discriminating between pictures; first, between preferred and non-preferred items (i.e., 3a) and then between preferred items (i.e., 3b), (4) building a sentence, (5) answering direct questions (e.g., “what do you want?”) using a sentence strip, and (6) commenting. Each subsequent phase builds on the skills acquired through earlier phases.

A consistent finding in the literature is that a variety of mediators (e.g., parents, teachers, direct care staff, university students) can be effectively trained to implement PECS with fidelity (e.g., Homlitas et al., 2014; Martocchio & Rosales, 2016; Park et al., 2011; Treszl et al., 2021; Wood et al., 2007). However, much of the prior research has not utilized a systematic training plan, or package, resulting in a lack of clear operationalization of the methods (e.g., Chaabane et al., 2009). As such, the dosage and format of training have varied considerably among studies demonstrating positive PECS mediator outcomes, making it hard to determine the essential components of effective PECS mediator training (e.g., Alsaydhassan et al., 2016; Carson et al., 2012; Treszl et al., 2021).

As caregivers play a pivotal role in their child's speech and language development, it is imperative caregivers are included in communication training so that they can support these skills outside of clinical settings (Park et al., 2011). However, few studies have been published that involve training caregivers to implement PECS with their autistic child (e.g., Carson et al., 2012; Chaabane et al., 2009; Greenberg et al., 2012; Park et al., 2011; Treszl et al., 2021). Alsayedhassan et al. (2016) reviewed the PECS mediator training literature and found that only five studies had focused on caregiver training. Further, the training methodology varied considerably and included written instructions with verbal explanations, physical and video modeling, in-situ practice with the child, and discussion around correct implementation, as well as other verbal feedback. While there are similarities in some of the training methods utilized, few of the reviewed studies evaluated an operationalized, systematic caregiver PECS training package. Further, only three of the reviewed studies reported on caregiver treatment integrity, the degree to which the intervention is applied as designed (Cooper et al., 2020). The lack of caregiver training research, sparse operational details, and the relative absence of treatment integrity data means that little is known about caregivers' ability to implement PECS and how to support caregivers efficiently and effectively to implement PECS with their children.

Behavioural skills training (BST; Miltenberger, 2008) is a well-established procedure for teaching skills in a wide range of areas. It involves instructions, modeling, rehearsal, and feedback (Miltenberger, 2008). Prior research has established this technology as an evidence-based training approach for caregivers of autistic children (Schaefer & Andzik, 2020). Behavioural skills training is commonly used to teach caregivers of children on the autism spectrum a variety of skills, such as delivery of reinforcement, use of discrete trial teaching (DTT), and use of prompting systems (Ferguson, et al., 2022; Sarokoff & Sturmey, 2004;

Schaefer & Andzik, 2021). Further, components of BST, as well as BST (in its entirety) as a systematic training method, have been used to train caregivers of children with autism to use PECS, resulting in improvements in caregiver teaching accuracy (Chaabane et al., 2009; Park et al., 2011; Treszl et al., 2021) and in their child's ability to utilize PECS to communicate (Chaabane et al., 2009; Greenberg et al., 2012; Park et al., 2011). It should be noted, however, that much of the prior research did not provide the results of the parent training intervention but focused on child outcomes (e.g., Carson et al., 2012; Greenberg et al., 2012).

General case training (GCT) is a second procedure which has been used to teach a variety of skills, such as teaching caregivers to implement discrete trial teaching with their children and training group home staff members how to teach personal care routines to their clients (e.g., Ducharme & Feldman, 1992; Ward-Horner & Sturmey, 2008). However, there has been less evaluation of this methodology in the current literature compared to BST. General case training was designed to teach skills in the context of a range of situations, with a variety of stimuli relevant to the skill being taught, in order to promote generalization (Ward-Horner & Sturmey, 2008). When using GCT, multiple teaching exemplars are carefully selected to ensure the range of stimuli and behaviours associated with the skill being taught are sampled (Ducharme & Feldman, 1992). Generalization is important within the context of PECS caregiver training, as caregivers will generally implement the procedures across multiple environments, within a variety of activities, using a diverse array of pictures and items of interest. Further, each child presents with a unique profile of strengths and weaknesses and caregivers need the skills to respond effectively to a variety of child behaviors, including correct and incorrect responses, even after intervention has ended.

Historically, research that utilized these methodologies implemented training in person. More recently, there has been an increase in research investigating the effectiveness of telehealth (i.e., services delivered via internet and videoconferencing technology [Blackman et al., 2020]), applications of BST (Ferguson, et al., 2022; Suess, et al., 2014; Thomlinson, et al., 2018), and BST combined with GCT (Shingleton-Smith., 2021; Treszl, et al., 2021). The combined approach of BST and GCT has been used to train caregivers to implement PECS phase 3b with their autistic child (Treszl et al., 2021) and to train caregivers of children at-risk for autism to implement behavioral teaching strategies to address early skill deficits associated with autism (e.g., imitation, requesting; Shingleton-Smith., 2021). While telehealth can increase the accessibility of services (Bekteshi et al., 2023; Dimian et al., 2018), certain barriers can exist when using telehealth services (e.g., weak internet connection, difficulty performing models or role-play, family resource limitations), resulting in varied approaches to its use (Heitzman-Powell et al., 2014, Thomlinson, et al., 2018).

Much of the research evaluating these models has demonstrated improvements in treatment integrity for mediators targeting social communicative behaviours, functional communication, and AAC (e.g., Ferguson et al., 2022; Suess et al., 2014; Treszl et al., 2021). However, to our knowledge, only one study has evaluated a telehealth approach to teach caregivers to implement PECS (i.e., Treszl et al., 2021). Although the results of this study, which combined BST and GCT technology, are promising, there were several limitations including the involvement of only one family and training only a single PECS phase.

Given the importance of engaging natural communication partners in AAC intervention and the limited resources available to support families, the identification of effective and efficient approaches for teaching caregivers to implement PECS is essential. Given the promise of telehealth technology in increasing the accessibility of services and the relative lack of research evaluating its use in PECS training specifically, the purpose of the current study was to extend the results of Treszl et al. (2021) and evaluate the effectiveness of a 2-week online training package using BST and GCT to teach caregivers how to implement PECS phases 1 to 3b (i.e., the *PECSperts Caregiver Training Package*). Further, given the need to ensure that services are both effective and accessible within community settings, purposeful attempts were made to create resource-efficient training approaches to enhance the social validity of the findings.

Method

Participants

Six families participated in the study. Three families had two caregivers in attendance; however, for the purpose of data collection, one caregiver was designated as the primary trainee (two fathers; four mothers; Table 2). Each family had a child with a confirmed diagnosis of ASD who was between the ages of 2 and 5. However, caregivers were the primary participants and children were not directly involved in this study. Participants were recruited through relevant social media platforms and through the project's community partner, a not-for-profit agency in Ontario, Canada that provides services for people with disabilities across the lifespan. Study information was distributed through the community partner agency, as well through social media via a poster which included the details of the study. Families were eligible for the study if their children (a) were diagnosed (or suspected/red flags) with a neurodevelopmental disorder (e.g., ASD, intellectual disability) as identified by a clinical psychologist, speech-language pathologist, or physician/pediatrician, (b) demonstrated significant communication deficits (e.g., fewer than 20 words used regularly as reported by caregiver), (c) were between the ages of 2 and 6 years, (d) did not have an established AAC system based on caregiver report, and (e) did not engage in significant challenging behaviour (e.g., self-injurious behaviour, aggression, tantrums). Caregivers were eligible for the study if they: (a) had not previously attended the official PECS Level One training, (b) were available to participate in scheduled research activities, and (c) had sufficient English language proficiency to participate in PECS training activities (Appendix A). Caregivers provided informed, written consent for their participation. This study received ethics clearance through a university research ethics board.

Table 2

Study One Participant Demographics

Participant	Age	Child Age (Years:Months)	Highest Level of Education Completed	Ethnicity
Brittany	42	3:0	College Diploma	White
Kevin	38	3:11	High School Diploma	White
Nick	40	5:1	Bachelor's degree	White
Michelle	32	4:8	College Diploma	White
Christina	33	3:0	College Diploma	White
Kelly	43	2:6	Bachelor's degree	White
Mean (SD)	38 (4.6)	3:8 (12.37 months)		

Note. Pseudonyms were assigned to each participant.

Materials and Measures

Prior to training, all caregivers received the PECS training manual (Frost & Bondy, 2006) and a standardized booklet containing the slides used in the PECS Level One training. To support practice opportunities during and after the training, each family also received a PECS communication binder (18.4cm by 15.9cm) with Velcro® affixed to the front, three binder insert pages with Velcro® affixed to each page, an assortment of 4cm by 4cm general and child-specific reinforcer pictures (e.g., snacks, drinks, toys, leisure items), and an assortment of putative reinforcers (e.g., squishy toys, pompom, a spinning top). Caregivers retained these resources for use with their children following completion of the study. To increase the ecological validity of the training, caregivers were encouraged to use items and activities that were of interest to their child during practice opportunities.

All data were collected on *Caregiver Treatment Integrity Checklists* designed by the research team. The checklists include a task analysis of the steps caregivers should take to implement PECS successfully at phases 1 (Appendix B), 2 (Appendix C), 3a (Appendix D), and 3b (Appendix E), e.g., setting up a communication trial, responding to correct and incorrect exchanges). The checklists were based on the PECS protocol described in the PECS Training Manual (Frost & Bondy, 2002) and were reviewed for accuracy by a consultant from Pyramid Educational Consultants (the creators of PECS). The number of steps per checklist varies from 13 to 19 depending on the teaching requirements of the phase. Refer to Table 3 for a sample.

Table 3

Sample Caregiver Treatment Integrity Checklist for Phase 1 of PECS

Communication Partner Steps
1. Arranges the environment effectively
2. Identifies the child's current preferences
3. Sets up the communication opportunity
4. Silently entices
5. Uses open hand effectively
Responding to a Correct Exchange
6. Accepts the picture
7. Delivers the reinforcer in ½ a second
8. Vocally labels the item
Responding to an Error
9. Places the picture back down in front of the child
10. Silently re-entices
Back Prompter Steps
1. Waits for the child to initiate

2. Physically prompts pick up, reach, and release
3. Fades prompts over trials
4. Provides no social interaction to the child

The social validity questionnaire for this study was based on the Treatment Acceptability Rating Form–Revised (TARF-R; Reimers & Wacker, 1992) which was designed to assess the acceptability and appropriateness of behavior change protocols and the social validity of the associated behavior change, and has good internal consistency (α = .92) and construct validity (as assessed through principal component analysis; Finn& Sladeczek, 2001; Reimers & Wacker, 1992). We revised the TARF-R to create a social validity questionnaire specifically for this study to better understand caregivers' perspectives on the PECSperts Caregiver Training package (Appendix F). The psychometric properties of the revised form are unknown. The revised form contained 21 items related to caregivers' ratings of their child's communication difficulties; their understanding and knowledge of PECS; the acceptability, reasonableness, and effectiveness of the teaching strategies; and their ability and willingness to continue using PECS after the study. Caregivers responded to each item on a Likert-type scale from 1 (e.g., *not at all acceptable*, *not at all reasonable*) to 5 (e.g., *very acceptable*, *very reasonable*). Space was also provided for caregivers to share additional feedback.

Setting and Equipment

All research activities, including recruitment and training activities, took place via telehealth using the Lifesize® video conferencing platform. Lifesize features screen sharing and videorecording features and meets established security criteria for protecting health information (e.g., encryption, secure data storage features, password access). Participants joined the Lifesize video conferencing room using their own laptop, tablet, or smartphone from their home. All PECS mediators used laptop computers with a camera, speakers, built-in microphone, and/or headphones and joined sessions from a private location in their own home. All sessions were video recorded on the Lifesize platform to allow for data collection, interobserver agreement calculation, and treatment integrity analyses.

Research Design

The study used a multiple-baseline-across-behaviours design, in which each phase of PECS represented a new behaviour (e.g., phase 1 implementation was behaviour 1, phase 2 implementation was behaviour 2). This design allowed for three within-participant replications of the training effect. Further, this design was implemented with all six participants, for a total of six multiple-baseline designs. This was the most appropriate single-case research design for the study, as each participant was taught a skill which could not be unlearned, which precluded the use of a reversal design. A multiple baseline-across-behaviours-design allowed for the most internally valid demonstration of experimental control, given the nature of these data.

Dependent Variable

The dependent variable was caregiver PECS teaching accuracy. Teaching accuracy was evaluated using the Caregiver Treatment Integrity Checklists for each phase. Each item on the relevant checklist was scored by a trained coder. Items were scored as correct if the step was performed as described, incorrect if the step was not performed as described or was omitted, and ‘not applicable’ if the participant did not need to perform the step (e.g., caregivers did not need to perform error correction during correct trials). To calculate caregiver PECS teaching accuracy, the total number of checklist steps scored correctly was divided by the total number of correct and incorrect steps and multiplied by 100. Caregivers were assessed on their overall PECS teaching accuracy when implementing PECS at phases 1-3b. Caregiver PECS teaching accuracy was evaluated at five time points: baseline, intervention, maintenance, and follow up (one and three months following the completion of the intervention).

Independent Variable

The independent variable, or intervention, was the introduction of a structured telehealth PECS training curriculum, PECSperts Caregiver Training package, following the baseline assessment. The PECSperts Caregiver Training Package was created through a collaboration between Pyramid Educational Consultants, Bethesda (a non-profit community agency providing supporting to youth and adults with developmental disabilities), and Brock University. The curriculum includes resources to teach PECS phases 1 to 3b. For each phase, the corresponding resources are available: (a) caregiver handout (Appendix G), (b) telehealth lesson plan (Appendix H), and (c) phase overview and scenario videos (see Appendix I for a description of the scenarios used). The curriculum incorporates the four components of BST, as well as GCT, and extends the work of Treszl et al. (2021) by including four phases of PECS (as well as more participants). Caregiver handouts include a rationale for why each phase is taught and a task-analysis of the steps required to teach each phase. The handouts include the same steps as the Caregiver Treatment Integrity Checklists. The telehealth lesson plans provide specific instructions and scripts mediators must follow when teaching each PECS phase. The lesson plans are designed to ensure that each PECSpert telehealth session provides caregivers with written instructions and rationale (in the form of caregiver handouts), models (in the form of live and video models, described below), practice opportunities, and performance feedback. For each phase, an overview video, as well as a variety of scenario videos were also developed. The overview video for each phase provides a step-by-step model of correct implementation, as well as a step-by-step model for conducting error correction. The scenario videos depict a variety of situations that may occur during PECS implementation. These scenarios include examples of independently correct trials, prompted correct trials, and trials in which error correction is required. The scenario videos constitute the GCT component of the intervention and include a variety of PECS communication book, picture, and reinforcer variations depicting the "instructional universe" caregivers may encounter when teaching PECS. The scenario videos were designed to ensure that participants were exposed to a variety of possible situations they may encounter while teaching PECS to their child, with hopes that generalization of PECS implementation would be enhanced. The caregiver handouts, lesson plans, and overview and scenario videos were created in consultation with a Pyramid Educational Consultants trainer, to ensure that the content closely approximated plausible PECS implementation experiences and accurate PECS implementation.

Procedures

Pyramid PECS Level One Training

At the start of the study, both caregivers and mediators, who included graduate students specializing in applied behavior analysis (ABA) and direct staff working in ABA services, attended the Level One PECS training offered through Pyramid Educational Consultants. This 2-day online workshop provides didactic instruction in the rationale and protocol for PECS, the six phases of PECS, and related topics in communication (Pyramid Educational Consultants, 2023). This training was provided to caregivers in advance of baseline assessment to mimic common practice in community settings, where caregivers are often encouraged to attend the training but may not receive follow-up support.

Mediator Training

Six mediators were recruited to facilitate the parent training sessions. Mediators were recruited from Bethesda and a Masters level graduate program in applied behavior analysis (ABA) at Brock University. A flyer was disseminated to Bethesda staff and graduate students using relevant listservs and course websites. Interested mediators participated in a telephone/video conference screening to determine whether they met the following criteria: (a) less than 1 year of experience supervising PECS implementation and/or training others to implement PECS, b) minimum one-year experience working with children/youth with neurodevelopmental disorders (e.g., ASD, intellectual disability) c) willing to participate in PECS Level One, and other required, training , and d) available to facilitate the scheduled parent training sessions. Four graduate students and two staff members from Bethesda were selected as mediators. Each mediator was randomly assigned to work with one caregiver for the duration of the intervention.

All mediators attended a 2-day, online training designed to orient mediators to the PECSperts resources and use BST to teach the mediators to implement the training model with the caregivers and collect data on caregiver PECS performance. Mediators were provided with a copy of all relevant handouts, training videos, and data sheets and received the BST training. Mediators were assessed to ascertain their treatment fidelity and IOA for data collection following the training. All mediators achieved >80% treatment integrity and interobserver agreement (IOA) in data collection following this training.

Baseline

During baseline assessments, participants were asked to demonstrate how they would respond to different scenarios at each of PECS phases 1, 2, 3a and 3b. Caregivers were asked to demonstrate their response to six phase 1 scenarios (three scenarios as the communication partner, i.e., the person receiving the picture during an exchange; three scenarios as the back prompter, i.e., the person providing necessary prompts during an exchange), and three scenarios for each of phases 2, 3a and 3b. In keeping with multiple-baseline design conventions, baseline assessment for phases 2 through 3b continued upon implementation of the phase 1 intervention. Baseline for 3a and 3b continued upon implementation of the phase 2 intervention, and baseline for 3b continued upon implementation of the phase 3a intervention.

Intervention

Following completion of phase 1 baseline, the PECSperts Caregiver Training package was introduced, and all participants began learning PECS phase 1. Each caregiver was assigned a single mediator who facilitated each of the daily training sessions. Caregiver training sessions were conducted online, once per day on weekdays for two weeks, for a total of 10 caregiver training sessions. Sessions were approximately one hour long and were conducted in a similar format, combining BST with GCT. First, caregivers received written and verbal instructions on the target PECS phase. Next, they watched an overview video model demonstrating the steps required to complete the target PECS phase. For example, participants were shown a video of a researcher implementing phase 1 following all steps of the fidelity checklist. Next, mediators presented caregivers with 10 video models depicting different scenarios they may encounter when teaching PECS to their child. The video models described a possible teaching scenario and then demonstrated the correct response to the scenario. Caregivers were then asked to demonstrate how they would respond to the scenario using their PECS binder and pictures. Following each trial, the mediator provided praise for steps implemented correctly and corrective feedback for steps completed incorrectly. If a caregiver responded incorrectly, they were required to demonstrate a correct response following the receipt of corrective feedback.

Following these 10 teaching trials, three probe trials were conducted, during which caregivers were asked to respond to three scenarios at the target phase, without a model and without any corrective feedback. The purpose of these trials was to probe the participant's ability to implement PECS at the target phase without any assistance from the mediator.

Caregivers were sequentially trained on phases 1, 2, 3a, and 3b and were required to meet a mastery criterion of 80% correct implementation fidelity on their probe trials across two days before being introduced to the next PECS phase. Following completion of these probe trials, caregivers completed additional baseline trials of upcoming phases and completed maintenance trials of phases they had previously mastered. For example, during phase 2 teaching, a caregiver would complete three probe trials of their phase 2 skills, three trials of phase 1 scenarios to assess their skill maintenance, and then three trials of phase 3b to collect baseline data on an untaught phase. Caregivers were exposed to all PECS scenarios described above and both teaching and probe scenarios were selected randomly to develop a training plan for participants (Appendix J). All participants followed the same training plan and were thus exposed to the same scenarios for teaching and probe trials.

Maintenance and Follow-Up

As mentioned prior, at the end of each teaching session for each phase, maintenance probes were used to assess short-term maintenance of previously taught phases. Following the conclusion of the study and withdrawal of caregiver training, four of the six participants completed follow-up probes one and two months post-training. Two participants, Michelle and Christina, did not complete follow-up probes. During follow up assessments, caregivers were asked to demonstrate how they would respond to three scenarios from all four of the PECS phases taught during the 2-week training. As with baseline and intervention probes, caregivers were not provided with feedback or coaching during maintenance probes or at follow-up.

Data Collection and Analysis

Data were collected during each training session. Following the formal training session, each caregiver completed three probe trials in which they were required to demonstrate correct implementation of a scenario without support from their mediator. These three datapoints comprise the intervention data. At the same time, caregivers were asked to complete baseline probes of future phases and maintenance probes of previously taught phases. The results of these probes constitute the baseline and maintenance data respectively. Data were collected from video after the completion of the intervention and were scored according to the Caregiver Treatment Integrity Checklists to obtain an overall caregiver PECS teaching accuracy score for each session. This score was derived from the average of the three trials the caregiver completed. For example, the datapoint for the first day of phase 1 intervention was the caregiver's mean PECS teaching accuracy across the three phase 1 probe trials.

Data were then graphed, and group-based results were analyzed using non-parametric statistics due to the small sample size. Related-samples Friedman's two-way ANOVA tests were used to test the change in caregiver PECS teaching accuracy change across the conditions in the study. Post-hoc pairwise analyses were also used to assess for change from baseline to intervention using a Bonferroni correction.

Interobserver Agreement and Treatment Integrity

Interobserver agreement was calculated using data collected from a random sample of baseline, intervention, maintenance, and follow-up sessions. Sessions were randomly selected (using an online randomizer tool: https://www.random.org/lists/) from each of the four PECS phases to ensure that all phases of training were subject to IOA analyses (i.e., 49% of phase 1 videos, 31% of phase 2 videos, 49% of phase 3A videos, and 38% of phase 3B videos). Overall, IOA was calculated for 42% of the datapoints. A trained research assistant, who was naïve to the purpose and procedures of the study as well as the condition (i.e., baseline, intervention, maintenance, follow-up) collected data on caregiver PECS teaching accuracy from Lifesize recordings. Mean interobserver agreement was 90% (range: 51% to 100%), 96% (range: 86% to 100%), 94% (range: 78% to 100%), and 87% (range: 67% to 100%) for phases 1, 2, 3a, and 3b respectively. Mean IOA across all four phases was 92% (range: 87% to 96%).

Treatment integrity of caregiver training sessions was assessed using a checklist (Appendix K) which evaluated whether the mediator implemented the caregiver training protocol as designed (e.g., if mediators provided accurate instructions, showed the video models, provided praise and corrective feedback, gave participants the opportunity to ask questions, etc.). To support high levels of treatment integrity throughout the study, approximately 30% of sessions (selected a-priori) were observed live by a member of the research team (i.e., a BCBA, BCBA-D/clinical psychologist, or graduate-level psychology/BCBA supervisee). Immediately following these sessions, the researcher provided the mediator with performance feedback (i.e., treatment integrity score, description of errors of omission or commission, praise). Formal treatment integrity data were collected by a trained research assistant following completion of the study. The research assistant scored a random selection of 25% of training sessions using the same treatment integrity checklist. Sessions were randomized (using the same online randomizer tool named above) within each PECS phase to ensure that integrity data were collected across all four PECS phases. Overall, mean treatment integrity was 99% (range: 95 to 100%).

Social Validity

Following completion of the intervention, and before the 1- and 3-month follow-up probes were conducted, caregivers were asked to complete the revised TARF-R.

Results

Caregiver PECS Teaching Accuracy

Brittany

At baseline, one mother, Brittany, demonstrated low rates of teaching accuracy, with an increasing trend, for phase 1 (Figure 1; *M* = 28%, range: 19% to 37%). Teaching accuracy immediately increased following implementation of the intervention (*M* = 91%, range: 77% to 100%). Maintenance and follow-up probes were at 100% accuracy. Brittany's phase 2 teaching accuracy followed a similar trend, with moderate, stable levels of performance at baseline (*M* = 48, range: 32% to 72%), followed by an immediate increase in level to 100% accuracy following intervention. Similar performance occurred during maintenance (*M* = 100%) and follow-up probes (*M* = 98%, range: 96% to 100%). Brittany's baseline phase 3a and 3b teaching accuracy was at a moderate level with an increasing trend (*M* = 50%, range: 26% to 76%; *M* = 49%, range: 32% to 68% for Phases 3a and 3b, respectively). For both phases, an immediate increase in level occurred upon implementation of the intervention (*M* = 98%, range: 96% to 100%; *M* = 100% for Phases 3a and 3b, respectively). These levels were maintained for phase 3a maintenance probes (*M* = 91%, range: 82% to 100%), phase 3a follow-up probes (*M* = 96%, range: 95% to 96%), and phase 3b follow-up probes (*M* = 99%, range: 98% to 100%).

Kevin

Kevin's phase 1 teaching accuracy was low and stable during baseline (Figure 2; *M* = 18%, range:16% to 21%). Teaching accuracy immediately increased following implementation of the intervention (*M* = 92%, range: 83% to 100%). Similar performance was observed during maintenance (*M* = 85%, range: 82% to 88%) and follow up probes (*M* = 98%, range: 95% to 100%). Teaching accuracy at phase 2 had an increasing trend at baseline (*M* = 44%, range: 13% to 61%) followed by an immediate increase in level during intervention (*M* = 96%, range: 92% to 100%). This level of performance continued during maintenance (*M*= 92%) and follow-up (*M* = 92%, range: 88% to 96%). A similar increasing trend in teaching accuracy occurred in baseline for phase 3a (*M* = 39%, range: 13% to 50%). An immediate increase in level occurred upon implementation of the intervention (*M* = 90%, range: 80% to 100%). This level of performance was not maintained during maintenance probes (*M* = 73%, range: 58% to 88%), but performance improved at follow-up (*M* = 89%, range: 87% to 91%). Baseline teaching accuracy for phase 3b was low and stable (*M* = 23%, range: 4% to 42%). Upon implementation of the intervention, teaching accuracy immediately increased (*M* = 96%, range: 93% to 100%), then diminished during maintenance *(M* = 82%, range: 64% to 100%), and was consistent at follow-up (*M* = 82%, range: 75% to 89%).

Nick

Nick's phase 1 teaching accuracy was high and stable during baseline (Figure 3; *M* = 78%, range: 76% to 79%). Teaching accuracy immediately increased following implementation of the intervention (*M* = 98%, range: 95% to 100%). These levels persisted during maintenance (*M* = 96%, range: 95% to 96%) and follow-up probes (*M* = 91%, range: 83% to 100%). Teaching accuracy at phase 2 had an increasing trend at baseline (*M* = 78%, range: 58% to 100%), followed by an immediate increase in overall level and reduction in variability during intervention (*M* = 100%). Similar levels were observed during maintenance (*M* = 100%) and follow-up (*M* = 91%, range: 87% to 95%). Teaching accuracy in baseline for phase 3a was moderate and stable (*M* = 70%, range: 67% to 78%). An immediate increase in level occurred upon implementation of the intervention (*M* = 100%). This high level of performance continued during maintenance probes (*M* = 91%, range: 89% to 93%) and at follow-up (*M* = 88%, range: 85% to 90%). Baseline teaching accuracy for phase 3b was at moderate to high levels and was variable (*M* = 78%, range: 67% to 96%). Upon implementation of the intervention, teaching accuracy immediately increased (*M* = 100%). Teaching accuracy continued at a high level during maintenance (89%) but diminished slightly during follow-up (*M* = 81%, range: 74% to 88%).

Michelle

Michelle demonstrated moderate levels of teaching accuracy and an increasing trend during the phase 1 baseline (Figure 4; *M* = 47%, range: 39% to 54%). Teaching accuracy immediately increased following implementation of the intervention (*M* = 96%, range: 91% to 100%). Similar results were observed during maintenance (*M* = 96%, range: 91% to 100%). Teaching accuracy at phase 2 was variable at baseline (*M* = 73%, range: 49% to 100%), followed by an immediate increase in overall level and reduction in variability during intervention (*M* = 100%). This high level and stable performance continued during maintenance (*M* = 96%, range: 92% to 100%). Teaching accuracy in baseline for phase 3a was relatively moderate and stable (*M* = 62%, range: 52% to 76%). An immediate increase in level occurred upon implementation of the intervention (*M* = 95%, range: 89% to 100%), but the level declined during maintenance (*M* = 77%, range: 69% to 85%). Baseline teaching accuracy for phase 3b was moderate and stable (*M* = 53%, range: 40% to 73%). Upon implementation of the intervention, teaching accuracy immediately increased (*M* = 100%) and persisted at a high level during maintenance (*M* = 88%).

Christina

Christina demonstrated low levels of teaching accuracy with an increasing trend during the phase 1 baseline (Figure 5; *M* = 31%, range: 19% to 43%). Teaching accuracy immediately increased following implementation of the intervention (*M* = 91%, range: 89% to 92%). These levels persisted during maintenance (*M* = 98%, range: 95% to 100%). Teaching accuracy at phase 2 was variable at baseline (*M* = 63%, range: 49% to 77%), followed by an immediate increase in overall level and reduction in variability during intervention (*M* = 98%, range: 96% to 100%). This high level and stable performance also occurred during maintenance (*M* = 96%, range: 92% to 100%). Teaching accuracy in baseline for phase 3a was moderate and stable (*M* = 47%, range: 36% to 60%). An immediate increase in level occurred upon implementation of the intervention (*M* = 96%, range: 92% to 100%) and this high level continued during maintenance (*M* = 95%, range – 89% to 100%). Baseline teaching accuracy for phase 3b was moderate with no discernable trend (*M* = 52%, range: 32% to 69%). Upon implementation of the intervention, teaching accuracy immediately increased (*M* = 100%) and persisted at a high level during maintenance (*M* = 100%).

Kelly

Kelly's phase 1 teaching accuracy had an increasing trend at baseline (Figure 6; *M* = 74%, range: 55% to 92%). Teaching accuracy immediately increased following implementation of the intervention (*M* = 100%). Similar levels were observed during maintenance (*M* = 100%) and follow-up probes (*M* = 100%). Teaching accuracy at phase 2 had an increasing trend at baseline (*M* = 74%, range: 64% to 92%), followed by an immediate increase in overall level and reduction in variability during intervention (*M* = 98%, range: 95% to 100%). This level of performance continued during maintenance (*M* = 96%, range: 92% to 100%) and follow-up (*M* = 100%). Baseline teaching accuracy for phase 3a had an increasing trend (*M* = 52%, range: 40%

to 70%). An immediate increase in level occurred upon implementation of the intervention (*M* = 94%, range: 88% to 100%). Teaching accuracy was lower during maintenance probes (*M* = 85%, range: 70% to 100%) but was higher during follow-up (*M* = 95%, range: 90% to 100%). Baseline teaching accuracy for phase 3b also had an increasing trend (*M* = 60%, range: 44% to 89%). Upon implementation of the intervention, teaching accuracy immediately increased (*M* = 100%) and persisted at a high level during maintenance (*M* = 100%) and follow-up (*M* = 100%).

Figure 1

Brittany's PECS Teaching Accuracy

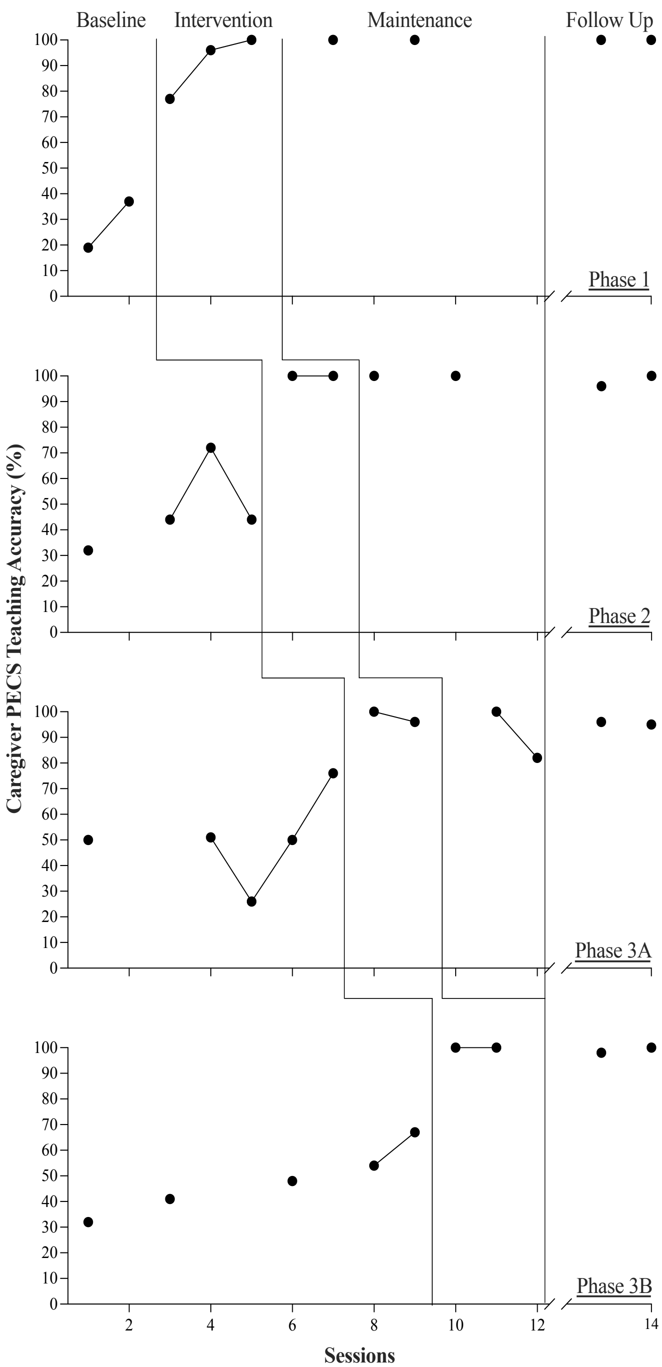


Figure 2

Kevin's PECS Teaching Accuracy

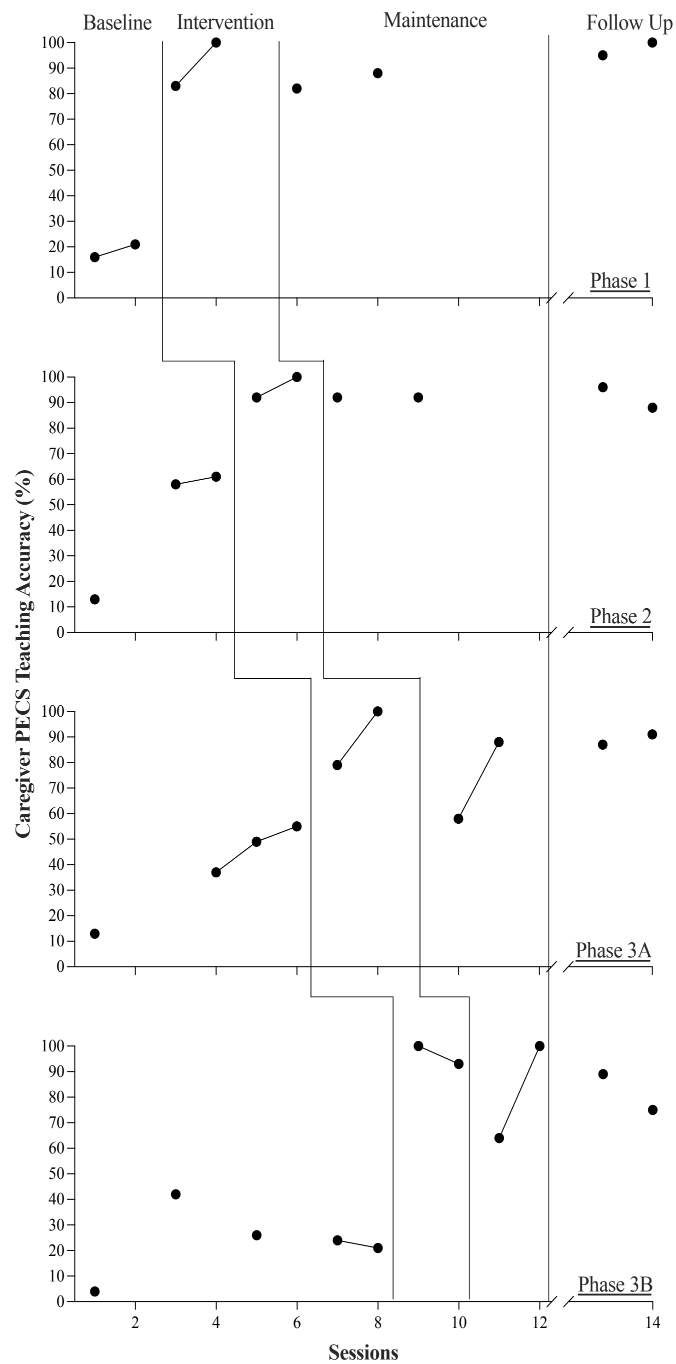


Figure 3

Nick's PECS Teaching Accuracy

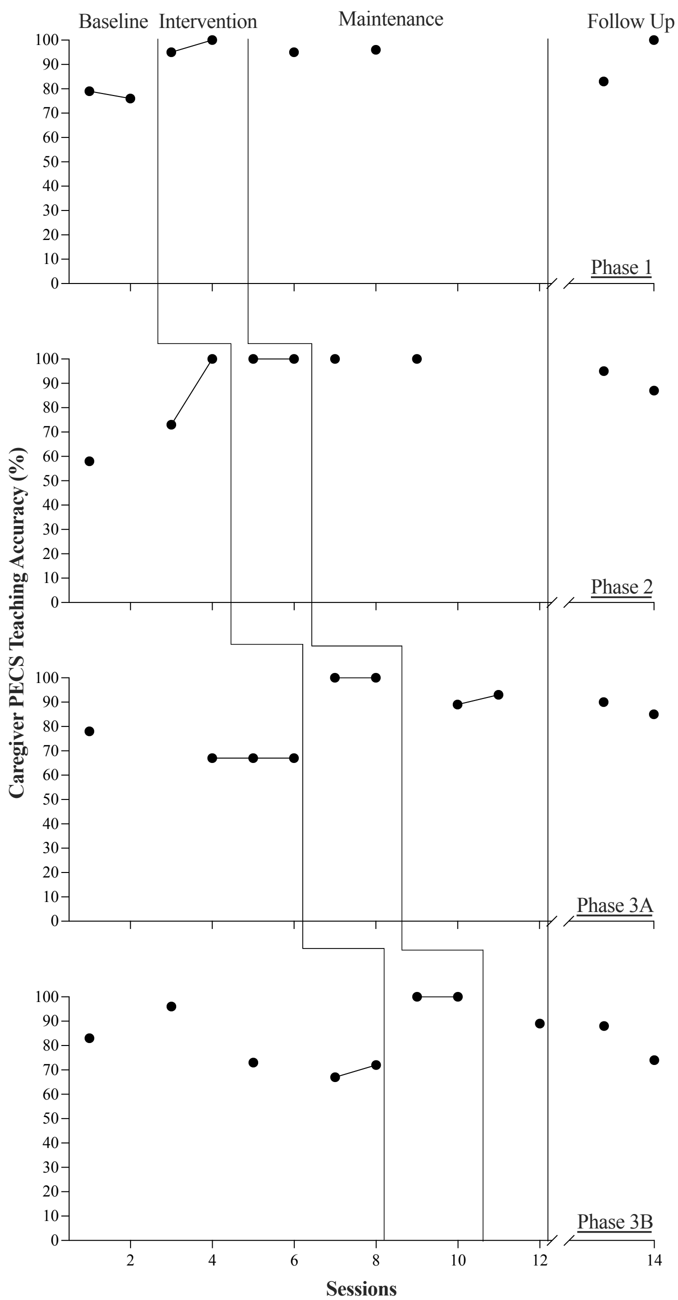


Figure 4

Michelle's PECS Teaching Accuracy

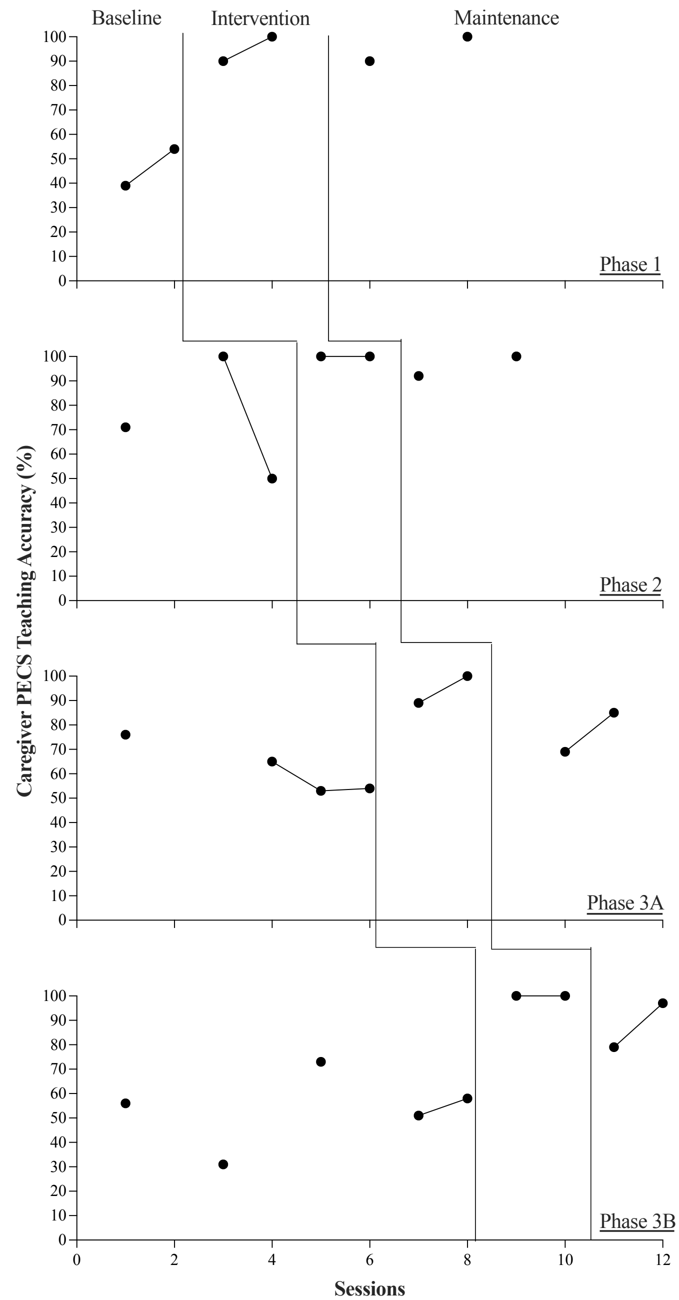


Figure 5

Christina's PECS Teaching Accuracy

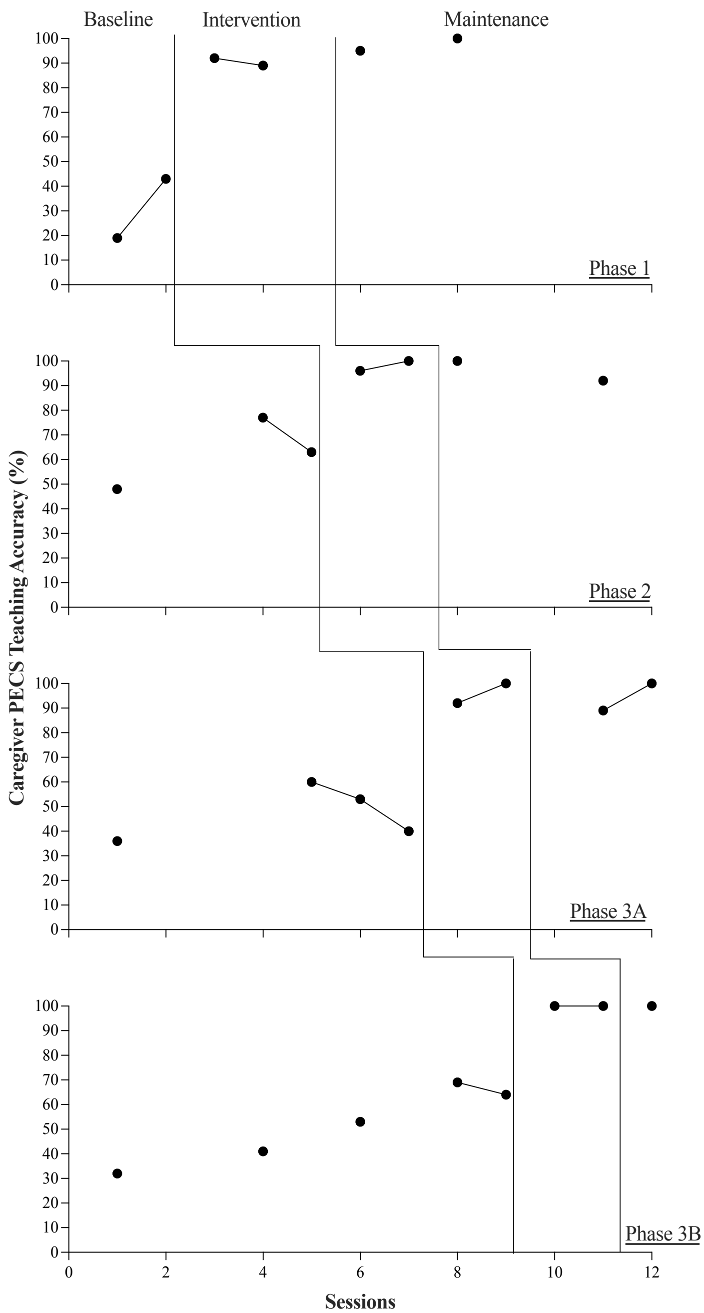
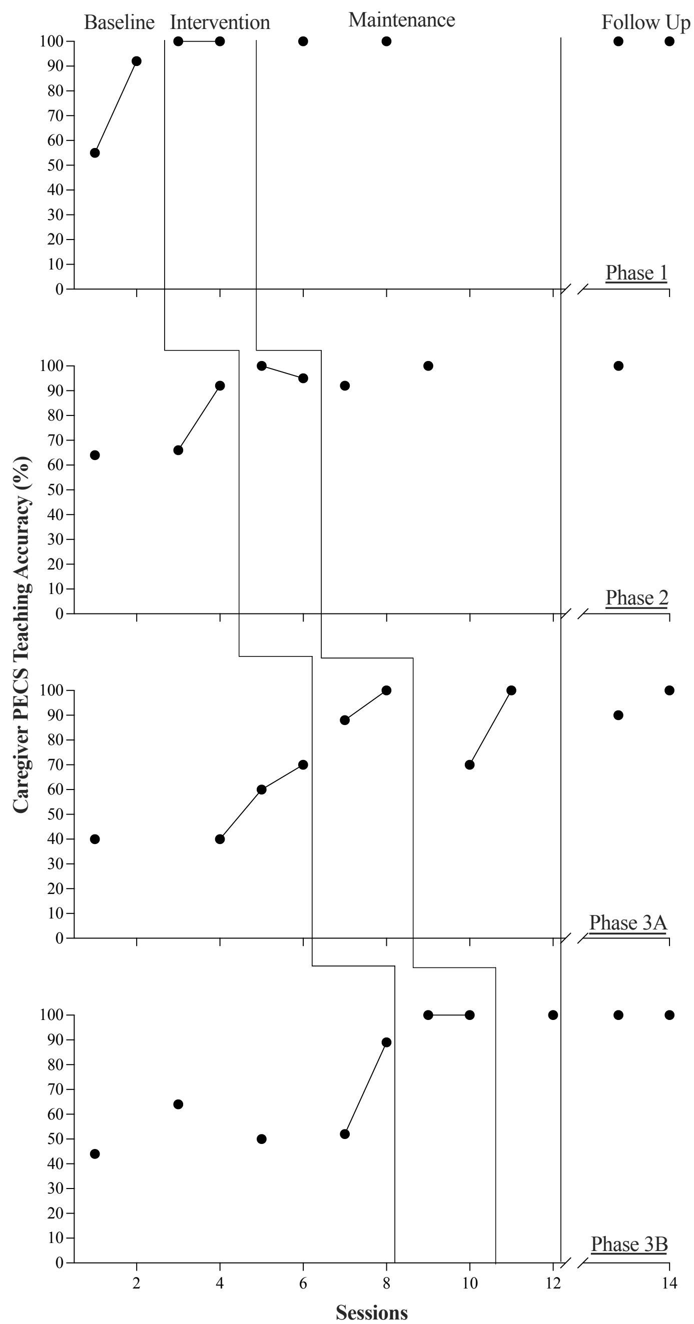


Figure 6

Kelly's PECS Teaching Accuracy

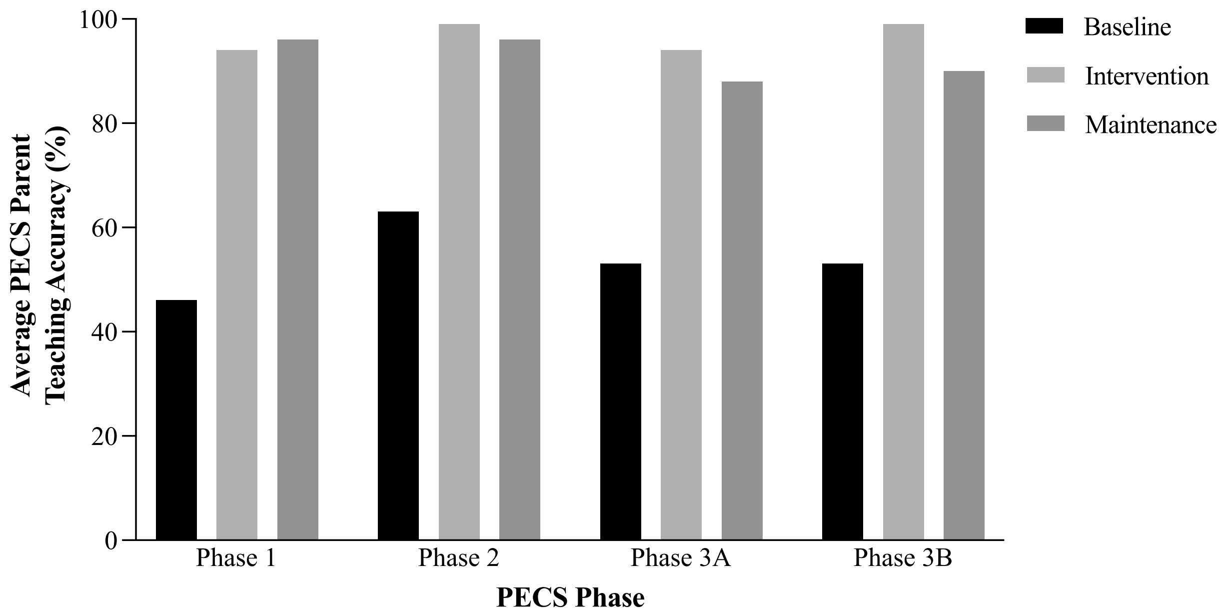


Group Results

Caregiver PECS teaching accuracy results were also evaluated in terms of overall group achievement (see Figure 7). Caregiver PECS teaching accuracy for phase 1 significantly improved over the course of the training, $\chi^2(2) = 9.82$, $p = .007$. Phase 1 teaching accuracy differed significantly between baseline and intervention ($T = -2.60$, $p = .009$) and remained stable with no significant difference between intervention and maintenance phases ($T = 0.0$, $p = 1.0$). Teaching accuracy for phase 2 significantly improved over the course of the training, $\chi^2(2) = 9.33$, $p = .009$. Similarly, phase 2 teaching accuracy differed significantly between baseline and intervention ($T = -2.89$, $p = .004$) but the difference between the intervention and maintenance phases was not significant ($T = .57$, $p = 1.0$). Teaching accuracy for phase 3a significantly improved over the course of the training, $\chi^2(2) = 12$, $p = .002$. Phase 3a teaching accuracy differed significantly between baseline and intervention ($T = -3.47$, $p = .001$) but the difference between the intervention and maintenance phases was not significant ($T = 1.73$, $p = .25$). Caregiver PECS teaching accuracy for phase 3b significantly improved over the course of the training, $\chi^2(2) = 11.27$, $p = .004$. Phase 3b teaching accuracy differed significantly between baseline and intervention ($T = -3.18$, $p = .004$), but not between the intervention and maintenance phases ($T = 1.16$, $p = .75$).

Figure 7

Group Mean PECS Teaching Accuracy Across Baseline, Intervention and Maintenance



Social Validity

All six participants completed social validity questionnaires. Mean social validity ratings of the overall goals of the treatment and the procedures are presented in Table 4. Overall, participants reported a high level of satisfaction with the procedures and a high level of confidence in their ability to implement PECS following the training. Of particular interest is that the lowest levels of participant satisfaction were for self-efficacy in implementing PECS after receiving only the Pyramid Educational Consultants PECS Level One online training. Clearly, participants felt that the additional 2-week PECSperts training improved their ability to implement PECS. Participants endorsed a very low rate of negative side effects from the intervention package as well as minimal discomfort.

Table 4

Study One Social Validity Results by Item

	Question	*M*	*SD*
1.	How clear was your understanding of PECS following the two-day training?	3.5	0.55
2.	How well did you think you could implement PECS following the two-day training?	2.33	0.52
3.	How clear was your understanding of PECS following the two-week online training?	5	0
4.	How well did you think you could implement PECS following the two-week online training?	4.67	0.52
5.	Overall, how acceptable did you find the PECS training and coaching that you received?	5	0
6.	Given your child's and family's needs, how reasonable did you find the online PECS caregiver training?	4.5	0.55
7.	To what extent did you think there were disadvantages in the online PECS caregiver training?	2.33	1.03
8.	To what extent did you think there were advantages in the online PECS caregiver training?	4.83	0.41
9.	How likely is this training to make ongoing improvements in your ability to teach your child to use PECS?	4.67	0.52
10.	How effective do you think PECS will be for your child?	4.67	0.52
11.	How much did you like the procedures used in PECS?	4.83	0.41
12.	How much did you like the procedures used in the online PECS caregiver training?	4.67	0.52
13.	How willing were other caregivers to help participate in the online PECS caregiver training?	4.67	0.82
14.	To what extent did undesirable side-effects result from the online PECS caregiver training?	1.6	0.89
15.	How much discomfort did you experience during the course of the online PECS caregiver training?	1.83	0.75
16.	How willing are you to continue to support your child's PECS use?	5	0
17.	How willing are you to change your family routine to carry out PECS?	4.83	0.41
18.	How well do you think PECS will fit into your family routine?	4.17	0.41
19.	How willing would you be to recommend PECS in the future?	4.83	0.41
20.	How willing would you be to recommend online PECS caregiver training in the future?	4.83	0.41

Note. Items 7, 14, and 15 are reverse scored.

Discussion

This study is the first to evaluate a telehealth training package (i.e., PECSperts Caregiver Training package) to teach caregivers how to implement the first four phases of PECS. All participants demonstrated increased PECS teaching accuracy across PECS phases 1 to 3b. These results persisted during maintenance and 1- and 3-month follow up probes. Notably, these positive gains were observed using research methods from both single-subject design graphs as well as non-parametric analyses of group data. Further, caregiver participants rated the training procedures, the PECS protocol, and their learning and performance outcomes highly. Overall, this brief telehealth training model was successful in teaching all participants how to implement PECS at phases 1 to 3b.

The results presented here are consistent with prior BST caregiver training research involving caregivers of children with ASD (e.g., Schaefer & Andzik, 2020; Suess et al., 2014). Further, the results extend those of Treszl et al. (2021), who evaluated this BST-GCT telehealth training package to teach one caregiver to implement one phase of PECS with their autistic child. The results also extend our understanding of caregivers' ability to accurately implement PECS teaching procedures by providing caregiver treatment integrity scores for each phase of PECS.

These results have implications for both practitioners and caregivers of children who use PECS specifically and AAC methods more broadly. The training model described above emphasizes the importance of caregivers in supporting the use of their child's AAC system. Prior research has demonstrated that caregiver involvement in child intervention enhances outcomes (e.g., Straus et al., 2012). As such, ensuring that caregivers feel empowered and capable of supporting their child's communication needs is an important intervention goal. It is noteworthy that these results were achieved with a relatively brief, resource-efficient training protocol. Participants were trained to teach the first four phases of PECS in only 10 hours of total training time. This relatively short duration is important for many reasons. More efficient training reduces the overall time demands placed on caregivers, which may allow more caregivers to fit training into busy personal and professional schedules, without increasing caregiver stress or burden. This advantage was reflected in the social validity results, with caregivers reporting a very low degree of discomfort when engaging with the training package Additionally, it may afford caregivers more time to practice and implement these skills with their child, potentially enhancing skill maintenance. Caregivers endorsed high satisfaction with the overall format of the training and their learning outcomes. With long waiting times to access services, and limited intervention funding, it is important to ensure that services are delivered as efficiently as possible, without compromising client outcomes. Equipping caregivers with the skills necessary to implement interventions can reduce the amount of funding spent on any one given skill area and can help support generalization and maintenance of these skills across environments and activities.

A related implication is the use of telehealth technology. As previously discussed, the intervention in its entirety was delivered using a telehealth format. All teaching and evaluation activities were conducted online, as were the mediator training components. While telehealth presents unique challenges (e.g., technical difficulties, access to reliable internet in rural and remote communities), it also creates the opportunity to provide services in a flexible fashion for families who may not be able to attend in-clinic appointments due to resources, geographic settings, or general caregiver preference. The ability to adapt and offer PECS training to families in a variety of formats may help increase accessibility and uptake among the most in-need populations who are not currently receiving these services.

The results of the present study also have implications for staff training. The current protocol demonstrated that it is possible to effectively train direct staff and graduate students, who had previously attended the PECS Level One training and had prior experience implementing PECS, within a relatively short timeframe (10.5 hours). Using evidence-based training procedures, including BST, to train the mediators resulted in rapid and durable acquisition of the PECSperts caregiver training protocol. During intervention, mean treatment integrity was 99%, indicating a high degree of teaching accuracy and skill maintenance.

Limitations and Future Directions

The current study is not without limitations. One is the ascending, and in some cases, high accuracy in baseline noted for many of the participants. At baseline, many participants showed either high or ascending levels of teaching accuracy. The issue of ascending baselines is likely due to two factors. The first is the placement of the PECS Level One online training. All participants attended this training prior to the initial baseline assessment. As such, participants entered the study with some knowledge of PECS and its proper implementation, which may have resulted in relatively high levels of accuracy during the baseline phase. A second contributing factor to this limitation is the skill overlap among the four phases. Despite each phase teaching different skills, many of the implementation steps are consistent across phases. For example, setting up the environment for success and assessing a learner's preferences are required steps in all four phases. Mastery of these skills during phase 1 training likely resulted in generalization of these skills to future phases. While this generalization is beneficial from a clinical perspective in that it can help reduce training demands and resources, it limits the experimental control of the research design. However, despite relatively high and ascending trends at baseline, none of the participants demonstrated a level of performance consistent with generally accepted standards for teaching proficiency (e.g., ≥80% accuracy), which would minimize the impact of treatment integrity errors (Brand et al., 2019; Wallace & Yassine, 2012). These results suggest that direct training, using evidence-based approaches (i.e., BST, GCT), may be necessary to support caregivers to develop high and stable levels of PECS teaching accuracy. Despite these limitations, all participants demonstrated immediate and sustained improvement in their teaching accuracy during intervention. Further, these results generally persisted during both maintenance and follow-up probes.

A second limitation to this study is the fact that caregivers were trained and assessed while working with a confederate without their children present. Although this was a reasonable choice for a pilot study evaluating a newly designed resource, it may reduce the ecological validity of the results. As previously discussed, caregivers demonstrated their response to various PECS implementation scenarios with their mediator. While the use of GCT was designed to ensure that caregivers practiced responding to a range of scenarios commonly encountered when teaching PECS (i.e., the instructional universe), without direct assessment of caregiver performance with their child it is unclear whether these implementation skills generalized to in-situ teaching with their child. This is an obvious and important goal for future research.

Despite these limitations, this study represents the first of its kind to evaluate a telehealth training model to teach caregivers how to implement multiple phases of PECS. Further, it is only the second study to explore the combined use of BST-GCT to support the development of a generalized PECS teaching repertoire. There are also several notable strengths, including the replication of effect across six participants and the use of group-level analyses to further evaluate the treatment effect within the context of a single subject research design.

Given the paucity of research in this area, there are numerous possibilities to expand the evidence base. Future studies should assess caregiver PECS teaching accuracy prior to any training. Specifically, initial baseline assessment should occur prior to caregiver receipt of PECS Level One training. A hierarchical intervention model assessing the additive contributions of the

PECS Level One training in addition to the telehealth training model would be beneficial. A second, and equally important, area for future research is to train caregivers with their children. Doing so would increase the ecological validity of the intervention and would allow mediators to support caregivers to manage the idiosyncratic challenges that may arise when caregivers work with their own child. Additionally, child progress should be evaluated following caregiver participation in training, allowing for analysis of child outcomes — arguably the most important indicator of the effectiveness of the PECSperts Caregiver Training package.

Conclusion

Following a brief telehealth training package, using both BST and GCT, all participants improved their ability to implement the first four phases of PECS. These results persisted during both maintenance and follow-up probes. The caregivers in this study indicated a very high degree of satisfaction with the intervention, highlighting that a telehealth model may be an effective, acceptable approach to caregiver training. Overall, telehealth technology appears to be an effective and efficient method to deliver PECS caregiver training and to improve the accuracy with which caregivers implement PECS. Importantly, the use of this technology may help empower parents of children on the autism spectrum who reside in remote and underserved areas where access to trained community clinicians is limited. It is hoped that these results spark further work into evaluating telehealth or hybrid caregiver training packages to ensure efficient and equitable access to AAC training and support.

Chapter 3: Evaluating a hybrid telehealth and in-person PECS caregiver training package on caregiver and child PECS outcomes

Introduction

Augmentative and alternative communication (AAC) systems have demonstrated effectiveness in teaching functional communication to children on the autism spectrum and those with other developmental disabilities (e.g., Ganz, 2015; Ganz et al., 2012; Syriopoulou-Delli et al., 2022). Despite the widespread use of AAC with this population, there is considerable variability in communicative outcomes (e.g., acquisition, generalization, and maintenance, McLay et al., 2015; Sievers et al., 2018; Sigafoos et al., 2014). It is hypothesized that this variability is due to an interplay of three factors (Sievers et al., 2018) including the AAC system being used, characteristics and skill level of the communication partner (e.g., fidelity of implementation, caregiver involvement), and variables associated with the child (e.g., cognitive functioning, autism symptom severity, pre-existing skill repertoires).

The Picture Exchange Communication System (PECS; Frost & Bondy, 2002) is one such AAC which has been studied extensively and is broadly considered an evidence-based approach to communication training for autistic children and youth (e.g., Hume et al., 2021; Wong et al., 2015). Similar to AAC more broadly, there are likely both communication partner and child factors that play a role in a child's success with PECS. For instance, caregivers are often children's primary PECS communication partners outside of educational and therapeutic settings (e.g., Park et al., 2011). Therefore, factors such as how caregivers are trained to implement PECS and how accurately they follow the PECS protocol (e.g., treatment fidelity) may impact child PECS outcomes. However, little is known about how to effectively involve, and train, caregivers as limited research has been done to explore PECS caregiver training. Similarly, child characteristics such as developmental/cognitive level, adaptive functioning, or previous acquisition of specific prerequisite skills may contribute to success with PECS. Although the developers of PECS (Frost & Bondy, 2002) assert that children do not require any prerequisite knowledge or skills to use PECS, this remains an empirical question as much of the prior PECS research has focused on general child communicative outcomes, rather than predictors of success (e.g., Flippen et al., 2010; Tien 2008). In order to promote positive child PECS outcomes, a greater understanding of the best way to support communication partner/caregiver training, maintenance of caregiver PECS implementation skills, and the role of child factors on PECS outcomes is warranted.

Caregiver training is an essential component of autism intervention, as it helps improve access to intervention (Burrell & Borrego, 2012) and improves generalization and maintenance of intervention outcomes (e.g., Straus et al., 2012). Relatedly, caregivers often serve as children's primary communication partners at home and their involvement may reduce system abandonment (Moorcroft et al., 2020). As such, it is reasonable to assume that effective and efficient caregiver training is essential to best outcomes in AAC generally and PECS specifically.

Behavioural skills training (BST; Miltenberger, 2008) is an evidence-based training approach which includes instructions, modelling, rehearsal, and performance feedback (Parsons et al., 2012; Schaefer & Andzik, 2020; Sun, 2022). Unlike didactic training, which generally functions to increase only knowledge about a topic, BST's main outcome measure is performance-based, meaning a trainee must demonstrate a predetermined level of proficiency (e.g., greater than 80% implementation accuracy) for the training to be considered complete (Parsons et al., 2012). Behavioural skill training has been used successfully to train caregivers of children with disabilities to implement a variety of procedures including social skills training (Hassan et al., 2018), requesting with speech generating devices (Suberman et al., 2020), and the use of differential reinforcement (Conklin & Wallace, 2019). Behavioural skills training has also been used successfully to train caregivers to implement PECS with their children (Chaabane et al., 2009; Park et al., 2011; Study one in this dissertation). In some instances, BST has been combined with general case training (GCT) to promote generalization of caregiver skills implementing PECS (e.g., Treszl et al., 2021) and to address early skill deficits associated with autism (e.g., imitation and requesting; Shingleton-Smith et al., 2021). General case training is a teaching strategy whereby a variety of teaching exemplars are chosen which represent the entirety of the instructional universe. Learners are then exposed to these exemplars and are trained on how to respond, thus training them across a variety of meaningful stimulus variations. In essence, learners are exposed to a range of teaching conditions which approximate what they will experience in their natural environment and are taught the corresponding response. Combined, BST and GCT are potent training methods to support caregiver skill acquisition and generalization.

Nearly all the published research in PECS caregiver training has involved face-to-face training (e.g., Carson et al., 2012; Park et al., 2011). Recently, as a direct result of the COVID-19 pandemic, there has been an increased interest in telehealth intervention, including in autism care (Ellison et al., 2021). While evidence suggests that telehealth is an effective method for delivering behaviour analytic services to children and their caregivers (Ellison et al., 2021), there is very little research directly evaluating telehealth and PECS training. Treszl and colleagues (2021) evaluated the effectiveness of a BST and GCT telehealth training to train one caregiver to implement phase 3b of PECS with their child. In this case, the telehealth training package was generally effective in improving caregiver PECS implementation accuracy. However, not all caregiver PECS teaching skills were reported to generalize to the natural environment and child PECS performance was variable. Further, this study only included one family, and trained only phase 3b of PECS as the child participant was a prior PECS user. These factors limit the generalizability of the results. More recently, and as described in study one of the dissertation, a 2-week telehealth training package (hereafter referred to as the PECSperts Caregiver Training package) was developed and implemented to train six caregivers to implement phases 1 to 3b of PECS. Although caregivers demonstrated improvements in their PECS teaching accuracy, there were several limitations to that study. Child outcomes were not assessed, meaning that no conclusions could be drawn about participants' PECS use with their children. Further, the baseline data were conflated with an initial didactic PECS training caregivers received through Pyramid Educational Consultants prior to commencing the PECSperts Caregiver Training package, making it difficult to ascertain how much the PECSperts Caregiver Training package affected caregiver PECS teaching accuracy above and beyond this initial training. The use of a multiple baseline design in this study proved problematic. Baselines of future teaching phases (i.e., Phases 2-3b) were influenced by teaching of earlier taught phases due to the considerable interphase skill overlap (e.g., removing distractions in the environment is the same across all phases taught), resulting in improvements in caregiver PECS teaching accuracy prior to receiving training on all PECS phases. This improvement in caregiver PECS teaching accuracy during baseline limited the internal validity of this initial evaluation.

Evaluations of child variables associated with AAC outcomes have generally focused on AAC as a broader category, with very few studies examining child variables and PECS outcomes. However, there is some evidence that a child's developmental/cognitive level is associated with PECS phase acquisition (Koudys et al., 2023; Pasco & Tohill, 2011). Specifically, a developmental level of 16 months predicted which children acquired phase 3 of PECS in one study (Pasco & Tohill, 2011), while another found that a developmental level of 22 months predicted which children would acquire phase 3b and beyond (Koudys et al., 2023).

Despite the relatively small sample size of these two studies (*n* = 22 and 23 respectively), as well as the retrospective nature of Pasco and Tohill's (2011) data, these two studies provide converging evidence that child developmental/cognitive level is associated with PECS outcomes. Conversely, a study by Gordon and colleagues (2011) found that baseline nonverbal intelligence was not associated with a child's PECS outcomes. They did, however, find that expressive language ability was associated with PECS outcomes, with fewer expressive language difficulties being associated with greater PECS intervention outcomes. More research is needed to fully understand the relationship between cognitive and developmental level and PECS outcomes.

In a systematic review, Sievers et al. (2018) evaluated predictors, moderators, and mediators associated with AAC success (including PECS). Of the six studies included in their review, three looked specifically at PECS. The studies included in the review examined different predictors of success, including child variables (developmental level, autism symptomatology, expressive language, object exploration, joint attention) and intervention variables (number of therapy sessions and level of caregiver involvement). Each study identified different factors associated with PECS success, with some identifying developmental and cognitive level and others identifying language ability. The literature evaluating various presumed prerequisite skills associated with AAC success is similarly inconsistent and much of the literature does not evaluate PECS outcomes specifically. While motor imitation and match to sample skills have been associated with positive outcomes with picture based AACs (Gregory et al., 2009; Valentino et al., 2019), joint attention does not seem to be necessary for success with PECS and, in fact, it may be a collateral area of skill development when PECS is implemented (Yoder & Stone, 2006).

Taken together, the literature is equivocal regarding the impact of child characteristics on success with PECS and picture-based communication systems. This is surprising given the relatively robust literature indicating that there are child characteristics associated with variations in outcomes in autism intervention more generally (Flanagan et al., 2012; Perry et al., 2011, 2013; Smith et al., 2015). One possible explanation for the variable findings reported above is that, to our knowledge, only three prior studies have evaluated the contribution of child characteristics to child PECS outcomes. Further, there are numerous limitations in the existing literature, including small sample sizes, reliance on unstandardized procedures (rather than the standardized PECS protocol), an absence of standardized data on child characteristics (e.g., IQ and adaptive functioning), and relatively weak experimental designs. As such, further research into the question, with rigorous experimental methodology, would expand the knowledge base around predictors of PECS success, which could help inform treatment selection and planning for children with particular clinical profiles.

The current project was designed to further our understanding of how to best train caregivers in a manner that enhances PECS teaching accuracy and maintenance to support positive child PECS outcomes. Further, it was designed to add a novel contribution to the growing literature on caregiver PECS training by integrating in-person and telehealth based training.

This study also acts as a direct extension of the PECSperts caregiver intervention developed in study one and addresses the limitations of the prior study, namely, the absence of a pure baseline and data on child PECS use. Finally, it adds to the small evidence base of child variables and their association with PECS outcomes. To address these limitations in the literature, and the limitations to the first PECSperts caregiver training study (study one), we asked the following research questions:

1) Is a hybrid caregiver training package (PECSperts Caregiver Training package) effective at improving caregiver PECS teaching accuracy use as evidenced by scores on an objective PECS phase assessment?
2) Does such a training package translate to improvements in child PECS use accuracy as evidenced by scores on an objective PECS phase assessment?
3) Are caregiver and child PECS skills maintained over time (e.g., 1 month, 3 months)?
4) Which child variables are associated with children's progression through the PECS protocol?
5) What is the social acceptability of the designed PECSperts Caregiver Training Package?

Methods

Participants

Caregivers and their children were recruited to participate in a multicomponent PECS intervention. Recruitment was completed with the assistance of community organizations that provided services to people with intellectual disabilities and neurodevelopmental disorders. Community partners disseminated a recruitment poster to clients currently receiving care and those on the waitlist and through various social media platforms (e.g., Facebook). Caregivers were invited to contact the recruitment coordinator to set up an eligibility meeting. Children recruited to participate were assessed for the following inclusion criteria: (a) diagnosed with a neurodevelopmental disorder (e.g., autism spectrum disorder, intellectual disability) or have suspected neurodevelopmental red flags as identified by a clinician involved in their care (e.g., clinical psychologist, speech language pathologist, physician), (b) demonstrate significant communication deficits (i.e., fewer than 20 spoken words) as reported by caregivers, (c) between the ages of 2 and 6 years, and (d) do not have a functional AAC system. Caregivers of children who met these criteria were invited to participate in the study (Appendix L).

Thirty-eight caregivers contacted the coordinator and 27 participated in an eligibility screening. Of these participants, 13 met the eligibility criteria and expressed interest in the study. Prior to beginning the study, one family dropped out due to scheduling difficulties. Three other families dropped out before beginning intervention due to scheduling and COVID-19 related concerns. This process resulted in a final sample of nine families (see Table 5 for caregiver demographics and Table 6 for child characteristics). One further caregiver (participant 7) did not complete follow-up assessments due to a family emergency. Caregiver participants had a mean age of 40 years (*SD* = 6.2) and child participants had a mean age of 55 months (*SD* = 15.8). While some participants involved a spouse or partner in the intervention, one caregiver was designated as the primary participant; demographic information (and later results) are based on that caregiver. Each child participated in a psychological assessment prior to beginning the PECSperts caregiver training. Participants' median age equivalent score (months) on the Mullen Scale of Early Learning, adaptive function total composite score (standard score) on the Adaptive Behaviour Assessment System, and total score (raw score) on the Childhood Autism Rating Scales (2nd edition) were obtained. This study received ethics clearance through a university research ethics board.

Table 5

Study Two Caregiver Participant Demographics

Family	Caregiver Age	Caregiver Sex	Caregiver Ethnicity	Caregiver Educational Attainment
1	47	Male	White	Postgraduate Degree
2	36	Female	Hispanic	Undergraduate Degree
3	31	Female	White	College Diploma
4	42	Female	White	College Diploma
5	35	Female	White	High School Diploma
6	39	Female	Black	College Diploma
7	38	Female	White	College Diploma
8	42	Male	White	College Diploma
9	51	Male	Hispanic	Undergraduate Degree
Mean (SD)	40.1 (6.17)			

Table 6

Study Two Child Participant Demographics and Assessment Scores

Family	Child Age (Years:Months)	Child Sex	Child Diagnosis	Child Median Age Equivalent Score on the MSEL (months)	Child ABAS Adaptive Composite Score	Child CARS-2 Total Score
1	2:6	Male	ASD + ID	4	62	42.5
2	2:8	Female	ASD	16	75	41
3	6:4	Male	ASD + ID	12	52	32.5

4	4:8	Female	ASD + ID	13	50	44.5
5	6:1	Female	ASD + ID	6	50	42
6	5:2	Male	ASD + ID	25	59	28
7	4:5	Male	Trisomy 21	20	--	20.5
8	4:9	Female	ASD + ID	8	46	34
9	5:0	Male	ASD + ID	17	62	39.5
Mean (*SD*)	4:7 (15mos)	--	--	13.4 (6.4)	57 (8.82)	36.06 (7.52)

Note. Intellectual Disability (ID) diagnoses were made following an assessment of each child's intellectual and adaptive functioning. Age equivalent scores were the median age equivalent across receptive and expressive language, fine motor, and visual reception scores on the MSEL. CARS-2 total raw score ranges were 15-29 (minimal to no symptoms of autism spectrum disorder), 30-36 (mild to moderate symptoms of autism spectrum disorder), 37 and higher (severe symptoms of autism spectrum disorder).

Materials and Measures

Prior to the start of training, all caregivers received the PECS training manual (Frost & Bondy, 2006) and a standardized booklet containing the slides used in the PECS Level One training. To support practice opportunities during and after the training, each family also received a PECS communication binder (18.4cm by 15.9cm) with Velcro® affixed to the front, three binder insert pages with Velcro® affixed to each page, an assortment of 4cm by 4cm general and child-specific reinforcer pictures (e.g., snacks, drinks, toys, leisure items), and an assortment of putative reinforcers (e.g., squishy toys, pompom, a spinning top). Caregivers retained these resources for use with their children following completion of the study. To increase the ecological validity of the training, caregivers were encouraged to use items and activities that were of interest to their child during practice opportunities.

Mullen Scale of Early Learning (MSEL)

The MSEL (Mullen; 1995) is designed to measure development in infants and preschoolers, ages birth to 68 months, in the domains of visual reception, fine motor skills, receptive language, and expressive language. The MSEL produces *T*-scores and age equivalent scores for each domain and is commonly used as a proxy measure of IQ for children with disabilities who cannot be tested with standard IQ measures (Farmer et al., 2016). It is commonly used in developmental disability assessment, especially for children with an ASD diagnosis (Akshoomoff, 2006) and shows strong convergent validity with the Differential Abilities Scale (DAS), a more traditional measure of intellectual functioning (Bishop et al., 2011; Farmer et al., 2016). The current study utilized a median age equivalent score, which was comprised by calculating the median of the visual reception, fine motor, receptive language, and expressive language scales. Age equivalent scores were utilized as some children were older than the upper limit of the normative data, precluding the use of *T* scores for the entire sample. The MSEL was used with children outside of the normative sample age range to allow for a standard comparison metric and to provide test items in the child's developmental range. This procedure has been used in prior research utilizing the MSEL with this population (e.g., Långe et al., 2022, Paynter et al., 2018).

Adaptive Behaviour Assessment System – 3rd Edition (ABAS-3)

The ABAS-3 (Harrison & Oakland, 2015) is a standardized caregiver report questionnaire used to measure adaptive behaviour across the lifespan (birth to age 89 years and 11 months) in the areas of communication, community use, functional academics, school behaviour, health and safety behaviours, leisure skills, self-care skills, self-direction, and social skills. The ABAS-3 generates scaled scores in each of these areas and generates composite standard scores for the conceptual, social, and practical domains, as well as a general adaptive composite score which provides a global estimate of the individual's adaptive functioning. It is often used to support the diagnosis of intellectual and developmental disabilities and developmental delays (Harrison & Oakland, 2015), with general adaptive composite standard scores below 70 indicating considerable difficulties with independence skills.

Autism Impact Measure (AIM)

The AIM (Kanne et al., 2014) is a caregiver-report questionnaire which asks caregivers to rate their child's level of autism symptoms. Specifically, it asks questions related to repetitive behaviours, communication, atypical behaviour, social reciprocity, and peer interaction. Caregivers rate both the frequency and the impact of the behaviour over the past two weeks. The scale consists of 41 items with a 5-point Likert-type response scale ranging from 1 (*never; not at all)* to 5 (*always; severely*). Completion of the AIM results in an overall frequency score (ranging from 41 to 205), an overall severity score (ranging from 41 to 205), and a global total sum score (ranging from 82-410), where lower scores reflect lower impact and frequency of the associated symptoms. Multiple psychometric studies have provided evidence for its reliability (Kanne et al., 2014), validity (Houghton et al., 2019; Mazurek et al., 2020; Zhong et al., 2023), and sensitivity to change over short periods of time (i.e., 6-week intervals; Mazurek et al., 2020). Mazurek and colleagues (2020) developed anchor-based, clinically meaningful change thresholds, and noted that a 4.5-point reduction in total score represents a clinically meaningful improvement in autism symptoms, while a 9.9-point increase in total score represents a worsening of symptoms.

Childhood Autism Rating Scale – 2nd Edition (CARS-2)

The CARS-2 (Schopler et al., 2010) is a direct observation clinical rating scale used to rate symptoms indicative of autism spectrum disorder. Observation of a child occurs in the context of a structured or unstructured interaction (e.g., during other assessment tasks, play, interaction with caregiver, etc.), allowing a trained rater to observe behaviours and symptoms associated with autism. Administration of the CARS-2 results in a total raw score, T-score, and percentile rank for the child's autism symptomatology. Raw scores correspond with a severity group: minimal to no symptoms of ASD (15-29), mild to moderate symptoms of ASD (30-36.5), or severe symptoms of ASD (37 and higher). The CARS is generally used as a supplemental assessment to assist in the assessment and diagnosis of autism. It has good psychometric properties when used by trained raters (Perry et al., 2005) including high internal consistency and acceptable sensitivity. The CARS-2 has poorer specificity (Moon et al., 2019).

Pre-Requisite Skills Assessment

A measure was developed for the purposes of this study to assess potential pre-requisite skills (Appendix M). This measure was loosely based on the Assessment of Basic Language and Learning Skills-Revised (ABLLS-R; Partington, 2006), a curriculum-based assessment which assesses a child's early learning skills including their language, imitation, visual performance (e.g., matching, visual discrimination), and social skills. This measure is commonly used in applied behaviour analysis (ABA) programming to assess a child's baseline skill level prior to implementing intervention. Select items across the visual performance, motor imitation, vocal imitation, and social interaction domains were administered. Specifically, the following items were probed over three trials: matching identical objects to sample, matching objects to pictures, matching pictures to sample, matching pictures to objects, gross motor imitation (arms out, clapping, touching head) verbal imitation ("ah," "mm," and "K"), and initiating and responding to bids for joint attention. These items were selected because they corresponded with prerequisite skills that had been identified as potential skills associated with PECS success in the literature (Sievers et al., 2018).

During the assessment, the examiner would provide a verbal instruction (e.g., do this, match, say "ahh") and allow the child 10 seconds to respond. If the child demonstrated the skill, the examiner would mark the trial as successful. If the child did not demonstrate the skill, the examiner would mark the trial as unsuccessful. Each skill was probed three times, giving the child three opportunities to demonstrate the skill. A total prerequisite skills score was derived by summing the correct trials across all the skills.

Caregiver Treatment Integrity Checklist

Caregiver PECS teaching accuracy was evaluated using the Caregiver Treatment Integrity Checklists for each phase (Appendix N). Items on the checklist outlined the standardized PECS implementation procedure for phases 1, 2, 3a, and 3b. Each item on the relevant checklist was scored by a trained coder. Items were scored as correct if the step was performed as described, incorrect if the step was not performed as described or was omitted, and as 'not applicable' if the participant did not need to perform the step (e.g., caregivers did not need to perform error correction during correct trials). To determine caregiver PECS teaching accuracy the total checklist steps scored correctly was divided by the total number of correct and incorrect steps and multiplied by 100. To calculate a caregiver's PECS teaching accuracy at each timepoint, their performance across phases 1, 2, 3a, and 3b were averaged to produce a mean PECS teaching accuracy score.

The caregiver treatment integrity checklist also recorded child PECS use accuracy, which was scored at the end of each trial. A correct trial was defined as the child exchanging the picture at the assessed phase independently, without prompting from the caregiver or assessor. An incorrect trial was defined as the child exchanging the picture with prompting from a caregiver or assessor or failing to exchange the picture. Children had three different opportunities at each phase to exchange, and thus their independent exchange performance was divided by three, and then multiplied by 100 to obtain a percentage correct score for each phase. To calculate a child's PECS use accuracy at each timepoint, their performance across phases 1, 2, 3a, and 3b were averaged to produce a mean PECS use accuracy score. Using the data in a non-averaged format would have resulted in considerable restriction of range issues because children could only score 0%, 33%, 66%, or 100% per phase (i.e., they only had three opportunities per phase to demonstrate the skill). Aggregating the data into a total PECS use accuracy score allowed for a much larger range of potential accuracy scores.

Social Validity Questionnaire

The social validity questionnaire for this study was based on the Treatment Acceptability Rating Form–Revised (TARF-R; Reimers & Wacker, 1992), which assesses the acceptability and appropriateness of behavior change protocols and the social validity of the associated behavior change. The TARF-R has good internal consistency ($\alpha = .92$) and construct validity (Finn & Sladeczek, 2001; Reimers & Wacker, 1992). The TARF-R was considerably revised for the initial implementation of the PECSperts Caregiver Training package (study one), and that revision was also used here to better assess the acceptability of the hybrid training approach (Appendix O). The psychometric properties of the revised social validity questionnaire are unknown. The revised form contains 28 items related to caregivers' ratings of their child's communication difficulties; their understanding and knowledge of PECS; the acceptability, reasonableness, and effectiveness of the teaching strategies; and their ability and willingness to continue using PECS after the study. The questionnaire also asks caregivers about their child's perceived progress and use of PECS to reflect the updated intervention format. Caregivers responded to each item on a Likert-type scale from 1 (*not at all acceptable*; *not at all* *reasonable*) to 5 (*very acceptable*; *very reasonable*). Space is also provided for caregivers to share additional feedback.

Setting and Equipment

Recruitment and the telehealth training activities took place using the Lifesize® video conferencing platform. Lifesize features screen sharing and videorecording features and meets established security criteria for protecting health information (e.g., encryption, secure data storage features, password access). Participants joined the Lifesize video conferencing room using their own laptop, tablet, or smartphone from their home. All PECS mediators used laptop computers with a camera, speakers, built-in microphone or headphones, and joined sessions from a private location in their own home. All virtual sessions were video recorded on the Lifesize platform to allow for data collection, interobserver agreement calculation, and treatment integrity analyses. In-person caregiver coaching sessions, and PECS phase assessments were held at the community partner agency's child services building. Within this building, sessions and assessment were conducted in treatment rooms which were furnished with a child-size table, two to three child-size and adult chairs, and a cabinet which held a variety of reinforcers (i.e., toys, games). Caregivers were encouraged to bring preferred edibles and toys or activities for use during coaching sessions and PECS phase assessments. Each room was equipped with an overhead camera to record all research activities.

Research Design

The study used a repeated-measures design in which each caregiver and child participant was assessed on their PECS use at five timepoints:

1. Baseline (prior to any training; T1),

2. Approximately ten days post PECS Level One training but before the PECSperts Caregiver Training (T2)
3. Two weeks following the conclusion of the PECSperts Caregiver Training (T3)
4. One month later (T4)
5. Three months following the end of the PECSperts Caregiver Training (T5).

A repeated-measures design overcomes many of the limitations of the initial evaluation of the PECSperts Caregiver Training Package (study one) such as the absence of an initial baseline and overlap of skills between phases affecting baselines. This design also allowed for the assessment of the relative contribution of each component of the intervention (i.e., PECS Level One training and the PECSperts Caregiver Training).

Dependent Variables

The dependent variables are caregiver PECS teaching accuracy and child PECS use accuracy. Caregiver PECS teaching accuracy is defined as the percentage of steps in the Caregiver Treatment Integrity Checklist that a caregiver was able to implement correctly. Child PECS use accuracy is defined as the percentage of assessment trials where the child independently exchanged a picture at the phase being assessed. Both dependent variables were evaluated using a PECS phase assessment which was designed specifically for this study. Specifically, the assessment was designed to evaluate (a) caregiver's ability to independently teach PECS phases 1 to 3b and (b) children's ability to independently implement PECS phases 1 to 3b. The evaluation criteria were based on phase-specific performance criteria and the PECS teaching protocol outlined in the PECS manual (Frost & Bondy, 2006). The phase assessment requires that caregivers conduct three trials of each phase (phases 1 to 3b) with their child for a total of 12 PECS trials. Both caregiver and child performance are then scored using the caregiver treatment fidelity checklist to derive scores for caregiver and child performance accuracy at each phase of PECS.

Independent Variable

The independent variable involved the introduction of two components, PECS Level One training and the PECSperts Caregiver Training Package following baseline assessment. The PECS Level One training is an online two-day didactic training delivered by Pyramid Educational Consultants PECS. The PECSperts Caregiver Training Package was created through a collaboration between Pyramid Educational Consultants, Bethesda (a non-profit community agency providing supporting to youth and adults with developmental disabilities), and Brock University. Representatives from Pyramid Educational Consultants reviewed the resources to ensure that the content was consistent with the PECS protocol as designed by Frost and Bondy (2006) and closely approximated plausible PECS implementation experiences. The PECSperts Caregiver Training Package includes both online (telehealth) caregiver training sessions and in-person caregiver-child coaching sessions. The telehealth component of the package uses the resources developed for and evaluated in the initial evaluation of the PECSperts Caregiver Training Package (study one). The training package includes resources to teach PECS phases 1 to 3b. For each phase, the corresponding resources are available: (a) caregiver handout (Appendix G), (b) telehealth lesson plan (Appendix P), (c) in-person caregiver-child coaching lesson plan (Appendix Q), and (d) phase overview and scenario videos (see Appendix R for a list of training scenarios). The curriculum incorporates the four components of BST as well as GCT. Caregiver handouts include a rationale for why each phase is taught and a task-analysis of the steps required to teach each phase. The caregiver handouts include the same steps as the Caregiver Treatment Integrity Checklists. The telehealth and in-person coaching lesson plans provide specific instructions and scripts mediators must follow when teaching each PECS phase. The lesson plans are designed to ensure that each PECSpert session provides caregivers with written instructions and rationale (in the form of caregiver handouts), models (in the form of live and video models, described below), practice opportunities, and performance feedback. For each phase, there is an overview video and a variety of scenario videos. These videos were used during the telehealth training component and were the same as those described in study one.

Caregiver-child coaching sessions utilized procedures consistent with the BST model, however given the idiosyncratic nature of caregiver-child coaching sessions, the procedures did not constitute a pure application of BST methodology. Each session began with a review of the instructions and parent handout of the current teaching phase. Mediators then provided a live model of the current phase where they demonstrated how to implement PECS with the caregiver's child. Caregivers were then given the opportunity to ask questions and/or roleplay the target PECS phase with the mediator and receive feedback on their performance. They-then received coaching (similar to that described by Gerow et al., 2021) while implementing the current phase with their child for a minimum of ten trials. Caregivers received positive and corrective feedback (as required) on all trials. As caregivers were working directly with their child, each trial was idiosyncratic, based on their child's performance. When caregivers received corrective feedback, they were encouraged to apply the feedback on the next trial if possible. However, a direct replication of trial was impossible, thus precluding the use of the full BST model.

Procedures

Baseline

Prior to receiving PECSperts caregiver training, participants attended a two-hour assessment appointment at the community partner agency. During this appointment, graduate students in psychology, under the supervision of a registered psychologist, administered the MSEL and the pre-requisite skills assessment. During this time, trained assessors also scored the child's behaviour using the CARS-2. While child participants completed these components of the assessment, caregivers were asked to fill out the ABAS-3 and the AIM.

Caregivers then participated in their T1 PECS phase assessment to evaluate their overall PECS teaching accuracy when implementing PECS at phases 1-3b. While caregivers were assessed on their ability to implement PECS, child PECS use accuracy was also assessed. During these assessments, caregivers were asked to implement three trials of PECS with their child, across all four phases. During these trials, caregivers had access to their child's PECS binder, picture, as well as a variety of reinforcers to contrive trials. No assistance was provided to caregivers during these assessment trials. Assessors acted as the back-up prompter in phases 1 and 2, when caregivers asked. At any phase, if children were unable to exchange independently, assessors supported children to exchange the picture. This assistance ensured that caregiver teaching accuracy was evaluated at each phase and ensured child participants' needs were met during the assessment. Child performance was scored "-"for these trials as per the scoring definitions. Assessments were video recorded for later coding by trained research assistants and for inter-observer agreement (IOA) calculations.

Pyramid PECS Level One Training

Following T1 assessments, both caregivers and mediators attended the Level One PECS training offered through Pyramid Educational Consultants as described in study one. Following the Level One training, caregivers were encouraged to begin implementing PECS with their children. Caregivers completed their T2 PECS phase assessment approximately ten days after this training, prior to the participation in the PECSperts Caregiver Training package.

Mediator Training

Mediators were recruited through a community partner agency (a non-profit agency providing services to individuals with intellectual and/or developmental disabilities), the Brock University Applied Disability Studies program, and the York University Clinical Developmental Psychology program. Mediators were responsible for implementing the PECSperts Caregiver Training package with all participants. Mediators were required to meet the following criteria: one year or more of experience working with children with disabilities and implementing ABA, able to attend the PECS Level One training offered through Pyramid Educational Consultants of Canada and two additional days of mediator training, and able to implement all components of the PECSperts Caregiver Training package. Six mediators were recruited. Mediators attended two separate training sessions prior to conducting caregiver training, as well as the PECS Level One training (described below).

One session was held online over the Lifesize video conferencing platform and the other was held in-person at the partner agency. Both training days utilized a BST model to train mediators on how to implement both the online and in-person training components. During this time, mediators were also trained and tested on their PECS implementation to ensure that they could teach all phases of PECS with high fidelity. The online training session ran for one full day and focused on utilizing the materials needed to successfully run the online component of the caregiver intervention. In accordance with BST, mediators were first given written and vocal instructions on how to conduct online training sessions. Next, a model was provided where two research team members modelled how to run an online caregiver training session. Following this, mediators practiced conducting online training sessions with other facilitators and members of the research team acting as confederate parents. Facilitators received both positive and corrective feedback on their implementation. During the practice opportunities, mediators became familiar with the GCT scenarios which would be used to train caregivers. Mediators were assessed on their ability to run online sessions and were required to meet a performance criterion of 80% implementation accuracy. The in-person mediator training session ran for one half-day and focused on training mediators to run the in-person caregiver-child coaching sessions. Like the online mediator training, the in-person mediator training session used BST and trained mediators how to implement all four phases of PECS that would be taught in the caregiver-child coaching sessions.

To support accurate implementation of the independent variable, 58% of the online caregiver training sessions and 67% of the in-person caregiver-child coaching sessions were chosen and observed and procedural fidelity data collected (Appendices R and T). All online and in-person sessions were observed during the first week to ensure accurate mediator implementation. The remaining supervision sessions were randomly selected. One mediator performed below the expected 80% criterion for procedural and was therefore replaced by the primary author of this paper, who met the mediator inclusion criteria. All other mediators consistently met and exceeded the 80% fidelity criteria (see below for procedural fidelity results).

PECSperts Caregiver Training Package

Online Caregiver Training. Following T1 assessments and the PECS Level One training, caregivers and their children participated in the PECSperts Caregiver Training package. Caregivers met online with a mediator and were instructed on one phase per week (i.e., phase 1 during the first week, phase 2 during the second week, etc.) without their child present. During these sessions, caregivers logged in to a Lifesize room and received instruction with another caregiver (i.e., two caregivers, one mediator), although three caregivers received individual online sessions due to scheduling challenges and participant attrition. As described earlier, training sessions included both BST and GCT. Caregivers received instructions on how to implement the current phase, watched an overview video model of the target PECS phase, and then practiced implementing the current phase in various scenarios (i.e., the "instructional universe"). Caregivers observed a variety of prerecorded scenario (e.g., "your child puts the picture in their mouth. What should you do as the communicative partner?") and were then shown a model of the appropriate solution (e.g., remove the picture, place it back on the table, and restart the trial). Caregivers then used the provided PECS binder, pictures, and reinforcers to practice how they would respond to each scenario. Mediators provided positive feedback for correct skill demonstration. Mediators provided corrective feedback if errors occurred and asked caregivers to practice the scenario until they demonstrated the correct implementation. Each caregiver practiced five to seven scenarios, depending on their rate of mastery (i.e., they practiced new scenarios until they demonstrated 80% fidelity over three consecutive practice trials). Following these teaching trials, each caregiver completed three assessment trials. During the assessment trials, caregivers were shown the beginning of a prerecorded scenario but were not shown the answer. They were then required to show the mediator how they would complete the trial while fidelity data were collected on their implementation. These assessment trials were designed to gauge the caregivers' level of PECS implementation accuracy prior to their weekly in-person session during which they implemented PECS with their child. Note that these assessment trials did not constitute the data for this study but allowed for mediator to track caregiver and child progress through the intervention package. This process was repeated for four weeks, with a different phase of PECS each week, until caregivers had received instruction on phases 1 to 3b.

Caregiver-Child Coaching Sessions. In addition to the online training component, caregivers and child participants also attended one in-person, caregiver-child coaching session each week. Caregiver-child dyads met weekly with their assigned mediator to receive coaching on the target PECS phase. Caregiver-child dyads were coached on one PECS phase per week (i.e., phase 1 during the first week, phase 2 during the second week, etc.). During these sessions, mediators demonstrated the target phase by conducting one to two model trials with the child. Caregivers then practiced implementing the target phase first with the mediator and then with their child over a minimum of 10 practice trials. Following each practice trial with their child, mediators provided positive feedback for steps completed correctly and corrective feedback for any steps that were completed incorrectly. Caregivers were then encouraged to apply the corrective feedback on the next trial with their child, however it was impossible to practice the same trial to mastery, given the idiosyncratic nature of each trial. Following these trials, caregivers were again assessed with three assessment trials during which no feedback was provided. Data were collected on both caregiver teaching accuracy and child performance (i.e., whether the child completed the exchange independently or incorrectly.

Follow-Up

Two weeks after the conclusion of the PECSperts Caregiver Training, participants completed their T3 PECS phase assessment. This assessment was identical to the T1 assessment. At this time, caregivers also completed the AIM to provide a measure of subjective autism symptom severity post-intervention. Children also completed the prerequisite skills assessment a second time.

Participants were asked to participate in T4 and T5 follow-up PECS phase assessments at one- and three-months post training. These assessments were the same as the T1 assessments. In addition, five participants agreed to partake in a 6-month follow-up interview to provide qualitative information on their child's PECS use. Caregivers who consented to this 6-month follow up met with a member of the research team, either virtually or over the phone (based on caregiver preference), to complete a semi-structured interview (Appendix U). This interview was 20 minutes in duration.

Statistical Analysis

Initial descriptives analyses were completed to provide insight into the nature and characteristics of the sample, as well as to explore general trends in caregiver PECS teaching accuracy and child PECS use accuracy. To assess the effect of the PECSperts Caregiver Training package on both caregiver PECS teaching accuracy and child PECS use accuracy, two piecewise multilevel models were fit. As mentioned prior, child PECS use accuracy and caregiver PECS teaching accuracy were each pooled across PECS phases for each timepoint. This resulted in one mean caregiver PECS teaching accuracy and one child PECS use accuracy score per timepoint, rather than four separate scores per timepoint (i.e., separate scores for each phase). This decision was made to increase the variability of child PECS use accuracy scores, which suffered from considerable restriction of range. Multilevel modelling was utilized to represent the repeated-measures design using growth curves (timepoints nested within participants). The data were graphed to visualize the learning trajectory of each participant, which revealed the need for a piecewise model rather than a linear or quadratic model for change over time (i.e., growth between timepoint one and three constituted one straight line, and growth between timepoint three and five constituted a second straight line). Both the caregiver and child model were estimated using a random intercept, fixed slope model, as the small sample size produced singularity warning when random slopes were estimated.

To evaluate the contribution of child variables assessed at T1 median age equivalent scores from the MSEL, adaptive function score from the ABAS, CARS total score, and T1 pre-requisite assessment total score were entered into the model individually. Five additional models were constructed to test each of these variables due to the small sample size which precludes the development of more complex models with multiple predictors. A Wilcoxon Signed Rank Test was conducted to assess change in AIM total scores from time one to time three. A nonparametric analysis was conducted due to the small sample size.

Interobserver Agreement and Treatment Integrity

Interobserver agreement was calculated using data collected from a random sample of PECS phase assessments across all five timepoints. Sessions were randomly selected from each of the five PECS phase assessment timepoints to ensure that all assessment timepoints were subject to IOA analyses (i.e., 33% of T1, 38% of T2, 50% of T3, 43% of T4, and 38% of T5 assessments). Overall, IOA was calculated for 40% of the assessment timepoints. A trained research assistant, who was naïve to the purpose and procedures of the study as well as the timepoint (i.e., T1, T2, T3, T4, T5), collected data on caregiver PECS teaching accuracy from the same overhead camera recordings used by the primary data collectors. Mean IOA for caregiver PECS teaching accuracy was 99% (range: 97% to 100%), 86% (range: 80% to 90%), 93% (range: 86% to 97%), 91% (range: 85% to 97%), and 93% (range: 87% to 96%) for T1, T2, T3, T4, and T5, respectively. Mean IOA across all five timepoints was 92% (range: 86% to 99%). Interobserver agreement was also collected on child PECS use accuracy. These data were collected from the same videos that were used to calculate caregiver PECS teaching accuracy IOA. Mean IOA for child PECS use accuracy was 100%, 100%, 100%, 97% (range: 89% to 100%), and 97% (range: 89% to 100%) for T1 to T5 respectively. Mean IOA across all five timepoints was 99% (range: 97% to 100%).

Treatment integrity of both online caregiver training sessions and caregiver-child coaching sessions was assessed using a treatment integrity checklist. The checklist evaluated whether the mediator implemented the caregiver training protocol as designed for each component of the training. To support high levels of treatment integrity throughout the study, 54% of online caregiver training sessions and 36% of caregiver-child coaching sessions were observed live by a member of the research team (i.e., a BCBA, BCBA-D/clinical psychologist or graduate-level psychology student/BCBA supervisee). Immediately following these sessions, the researcher provided the mediator with performance feedback (i.e., treatment integrity score, description of errors of omission or commission, praise). All mediators were supervised and assessed for treatment integrity during their first online caregiver training session and their first caregiver-child coaching session. Remaining session selection was randomized. Overall, mean treatment integrity was 95% (range: 64% to 100%) for online caregiver training sessions and mean treatment integrity was 92% (range: 72% to 100%) for caregiver-child coaching sessions.

Social Validity

Following completion of the intervention at T3, caregivers were asked to complete the social validity questionnaire.

Results

Caregiver PECS Teaching Accuracy and Child PECS Use Accuracy

Descriptive analyses of the PECS accuracy data for both caregivers and children revealed increases in mean accuracy from T1 to T3 (Table 7). Further, most caregivers and children displayed mastery of all four phases at T5 (Table 8).

Table 7

Mean Caregiver PECS Teaching Accuracy and Child PECS Use Accuracy

	Mean Caregiver PECS Teaching Accuracy % (*SD*)	Mean Child PECS Use Accuracy % (*SD*)
T1	4.72 (9.82)	0.92 (5.5)
T2	44.59 (24.06)	21.81 (37.45)
T3	88.21 (10.64)	70.67 (34.5)
T4	86.25 (13.14)	74.79 (32.35)
T5	86.56 (10.78)	72.69 (34.39)

Note: *n*=9 at T1, *n*=8 at T2, *n*=6 at T3, *n*=7 at T4, *n*=8 at T5

Table 8

Number of Participants who Mastered Each PECS Phase at Timepoint 5

	Caregivers *n* (%)	Children *n* (%)
Phase 1	5 (63)	7 (88)
Phase 2	6 (75)	6 (75)
Phase 3a	6 (75)	5 (63)

Phase 3b	7 (88)	7 (88)

Note. *n*=9 at T1, *n*=8 at T2, *n*=6 at T3, *n*=7 at T4, *n*=8 at T5

An unconditional piecewise linear growth model was fit to estimate the treatment effects of the PECSperts Caregiver Training package for both caregiver and child PECS use. Results indicated that caregiver PECS teaching accuracy improved significantly between T1 and T3: caregiver PECS teaching accuracy improved by 41.17% per timepoint (i.e., when moving from T1 to T2, and then T2 to T3; $p < .001$). Caregiver PECS teaching accuracy did not change significantly between timepoints 3 and 5 ($p = .78$), indicating that improvements between T1 and T3 maintained through T5. Refer to Table 9 and Figure 8.

Table 9

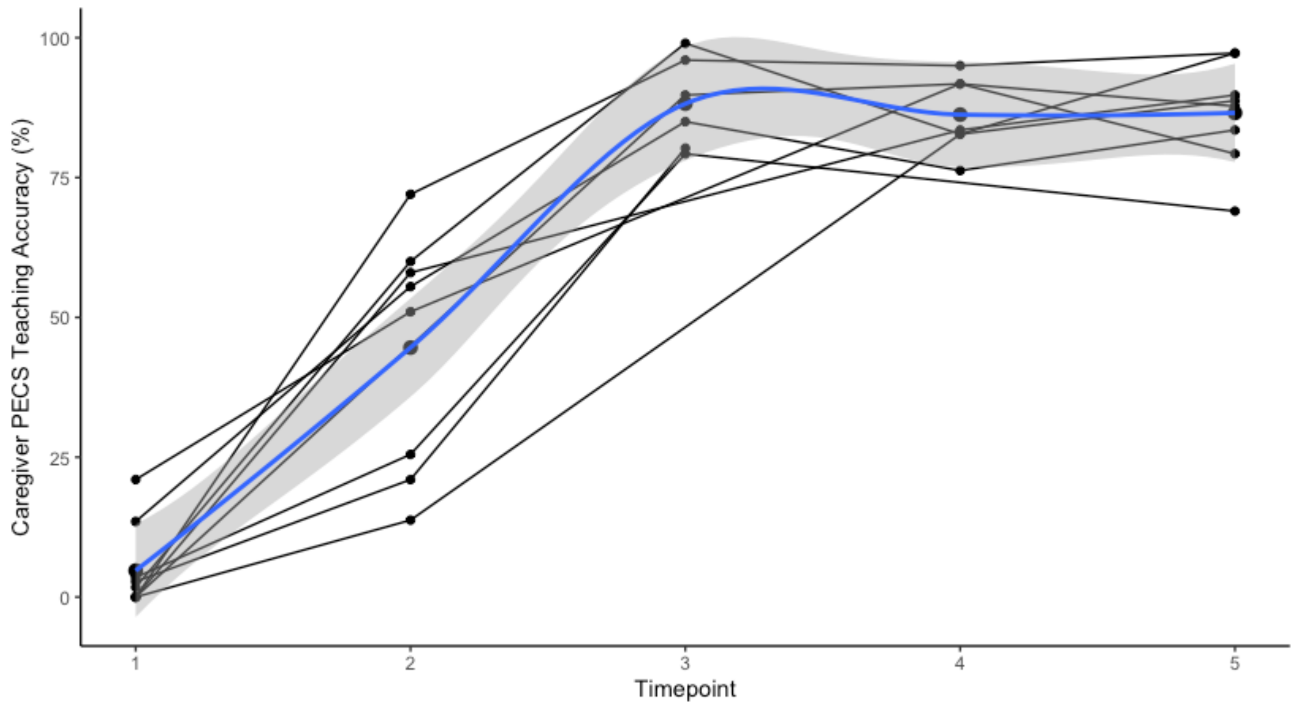
Piecewise Regression Model for Caregiver PECS Teaching Accuracy

	Estimate	Standard Error	Standard Deviation (Random Effect)	*t*	*p*
Intercept (level at T3)	85.2	3.96	6.19	21.51	<.001
Segment 1 slope (T1-T3)	41.18	2.54	--	16.2	<.001
Segment 2 slope (T3-T5)	-.76	2.62	--	-0.29	0.78

Note. Intercepts were random and slopes were fixed effects.

Figure 8

Caregiver PECS Teaching Accuracy Trajectories Across all Timepoints



Note. One data point per participant reflects the average caregiver teaching accuracy across phases 1, 2, 3a, and 3b at the specified timepoint. Group mean caregiver PECS teaching accuracy at each timepoint is illustrated by the blue line, while the grey shaded area represents the 95% *CI* around the mean trajectory.

Child PECS use accuracy improved significantly by 34.25% per timepoint from T1 to T3 (p <.001). Child PECS use accuracy did not change significantly between timepoints 3 and 5 (p = .47), indicating that improvements between T1 and T3 maintained through T5. Refer to Table 10 and Figure 9.

Table 10

Piecewise Regression Model for Child PECS use Accuracy

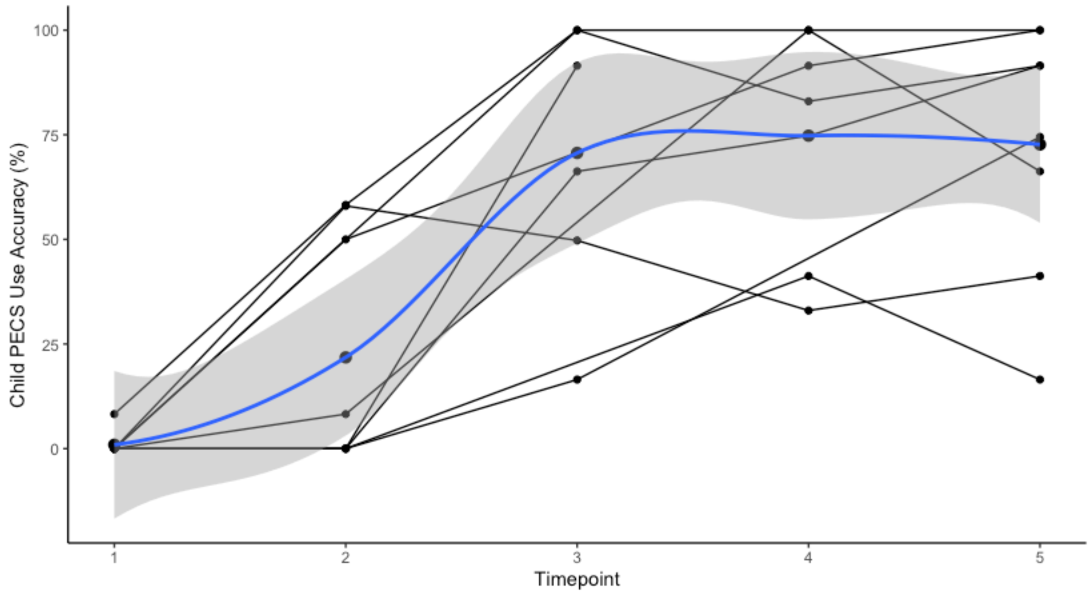
	Estimate	Standard Error	Standard Deviation (Random Effect)	*t*	*p*
Intercept (level at T3)	73.9	8.63	14.76	8.56	<.001

Segment 1 slope (T1-T3)	34.25	5.32	--	6.43	<.001
Segment 2 slope (T3-T5)	4.01	5.5	--	-0.73	0.47

Note. Intercepts were random and slopes were fixed effects.

Figure 9

Child PECS use Accuracy Across all Timepoints



Note.
One data point per participant reflects the average child PECS use accuracy across phases 1, 2, 3a, and 3b at the specified timepoint. Group mean child PECS use accuracy at each timepoint is illustrated by the blue line, while the grey shaded area represents the 95% *CI* around the mean trajectory.

Child Characteristics

Child median age equivalent on the MSEL, adaptive composite on the ABAS, total autism severity score on the CARS-2, and T1 pre-requisite skills were not significantly associated with child PECS use accuracy (all *p*s > .05; Tables 11, 12, 13, and 14). There was no main effect of these variables, nor did they significantly predict change over time.

Table 11

Piecewise Regression Model for Child PECS Use Accuracy with Age Equivalent on the MSEL Predicting PECS Use

	Estimate	Standard Error	Standard Deviation (Random Effect)	*t*	*p*
Intercept (T3 level)	50.29	17.56	11.31	2.86	<.001
Segment 1 slope (T1-T3)	17.91	11.96	--	1.5	.15
Segment 2 slope (T3-T5)	9.8	12.03	--	.82	.42
MSEL Median AE	1.88	1.23	--	1.52	.14
AE*Segment 1	1.18	.77	--	1.52	.14
AE*Segment 2	-.34	.81	--	-.42	.68

Note. Intercepts were random and slopes were fixed effects. AE refers to the median age equivalent score on the Mullen Scales of Early Learning.

Table 12

Piecewise Regression Model for Child PECS Use Accuracy with Total Adaptive Composite Score on the ABAS Predicting PECS Use

	Estimate	Standard Error	Standard Deviation (Random Effect)	*t*	*p*
Intercept (T3 level)	-10.95	55.5	15.93	-.20	.85
Segment 1 slope (T1-T3)	-36.38	37.01	--	-.98	.34
Segment 2 slope (T3-T5)	14.51	36.95	--	.39	.70
Adaptive Composite Score	1.49	.96	--	1.55	.14
Adaptive Composite Score*Segment 1	1.22	.65	--	1.87	.07
Adaptive Composite Score*Segment 2	-.18	.65	--	-.27	.79

Note. Intercepts were random and slopes were fixed effects. Adaptive composite score refers to the overall score reflecting adaptive function on the Adaptive Behaviour Assessment System (3rd edition).

Table 13

Piecewise Regression Model for Child PECS Use Accuracy with Total Score on the CARS-2 Predicting PECS Use

	Estimate	Standard Error	Standard Deviation (Random Effect)	*t*	*p*
Intercept (T3 level)	71.75	58.04	15.42	1.23	.25
Segment 1 slope (T1-T3)	69.03	24.41	--	2.83	<.001
Segment 2 slope (T3-T5)	-34.34	32.04	--	-1.07	.29
CARS score	.04	1.52	--	.02	.98
CARS score*Segment 1	-.98	.67	--	-1.47	.16
CARS score*Segment 2	1.07	.85	--	1.36	.22

Note. Intercepts were random and slopes were fixed effects. CARS score refers to the overall score reflecting autism symptom severity on the Childhood Autism Rating Scales (2nd edition).

Table 14

Piecewise Regression Model for Child PECS Use Accuracy with Total Score on the Pre-requisite Skills Assessment Predicting PECS Use

	Estimate	Standard Error	Standard Deviation (Random Effect)	*t*	*p*
Intercept (T3 level)	78.13	12.97	16.33	6.02	<.001
Segment 1 slope (T1-T3)	31.34	7.46	--	4.2	<.001
Segment 2 slope (T3-T5)	8.57	8.06	--	1.06	.29
Prerequisite score	-.88	1.82	--	-.48	.63
Prerequisite score*Segment 1	.35	.67	--	.54	.59
Prerequisite score*Segment 2	-.74	.99	--	-.75	.46

Note. Intercepts were random and slopes were fixed effects. Prerequisite score refers to the overall score reflecting a child's prerequisite skills at T1.

Parent-perceived autism symptom severity at T3 (as measured by the AIM total score) declined significantly from T1 (M = 173.33, SD = 28.93) to post-intervention (T3; M = 144.57, SD = 22.24; t = 2, p = .043).

Social Validity

Six of the nine caregivers completed the social validity questionnaire following completion of the PECSperts Caregiver Training. Overall, caregivers rated the PECSperts caregiver training as highly effective with minimal side-effects or negative effects on their day-to-day life. Mean social validity scores per item are in Table 15. Caregivers reported a high level of satisfaction with the PECSperts caregiver training procedures. Notably, all caregivers indicated that they were very willing to continue supporting PECS use in the household. Caregivers also indicated that their children improved their PECS use following the training. The lowest level of participant satisfaction was self-efficacy with implementing PECS after the PECS Level One training. Participants reported much higher feelings of self-efficacy with implementing PECS following the completion of the PECSperts Caregiver Training, which corresponds with the objective caregiver PECS accuracy data presented above. Parents consistently endorsed the caregiver-child coaching sessions as an essential ingredient for the success of the overall training package, noting that these sessions helped solidify the information learned during online caregiver training sessions.

Table 15

Study Two Social Validity Results by Item

Question	*M*	*SD*
1. How clear was your understanding of PECS following the two-day training?	3.5	1.64
2. How well did you think you could implement PECS following the two-day training?	2.33	1.21
3. How clear was your understanding of PECS following the four-week training?	4.83	0.41
4. How well did you think you could implement PECS following the four-week training?	4.33	0.82
5. Overall, how acceptable did you find the PECS training and coaching that you received?	5	0
6. Given your child's and family's needs, how reasonable did you find the four-week PECS caregiver training?	4.5	0.84

7. To what extent did you think there were disadvantages in the four-week PECS caregiver training?	1.67	1.21
8. To what extent did you think there were advantages in the four-week PECS caregiver training?	4.33	0.82
9. How likely is this training to make ongoing improvements in your ability to teach your child to use PECS?	4.67	0.52
10. How much did you like the procedures used in PECS?	4.33	0.52
11. How much did you like the procedures used in the four-week PECS caregiver training?	4.83	0.41
12. How willing were other caregivers to help participate in the four-week PECS caregiver training?	3.33	0.52
13. To what extent did undesirable side-effects result from the four-week PECS caregiver training?	1.83	1.17
14. How much discomfort did you experience during the course of the four-week PECS caregiver training?	1.67	0.52
15. How willing are you to continue to support your child's PECS use?	5	0
16. How willing are you to change your family routine to carry out PECS?	4.5	0.55
17. How well do you think PECS will fit into your family routine?	4.17	0.75
18. How willing would you be to recommend PECS in the future?	4.6	0.55
19. How willing would you be to recommend the four-week PECS caregiver training in the future?	4.5	0.84
20. How well do you think your child could use PECS BEFORE the PECS training?	1.33	0.82
21. How well do you think your child could use PECS AFTER the PECS training?	4.5	0.84
22. How effective do you think the PECS training was for your child?	4.5	0.55
23. How well do you think your child enjoyed working with you during the PECS training?	4.5	0.84
24. How effective do you think PECS will be for your child in the future?	4.33	0.52

Note: Items 7, 13, and 14 are reverse scored

Six-Month Follow-up

Six months following completion of the PECSperts Caregiver Training, all interviewed parents (*n* = 5) indicated that their child was still using PECS. Two of the participants noted that their child was using PECS at a phase not taught in the training (phase 4 and 5). All caregivers indicated that they had worked with their child's school or daycare to support PECS use in these environments.

Discussion

This study is the first to evaluate a structured hybrid (i.e., telehealth and in-person) PECS training model for caregivers and children. It is also a direct extension of the telehealth PECSperts Caregiver Training package originally described in study one. All caregiver participants demonstrated improvements in their PECS teaching accuracy and child participants generally demonstrated an improvement in their PECS use accuracy across phases 1 to 3b. However, there was much greater variability in child outcomes when compared to caregiver outcomes. Both caregivers and children maintained their treatment gains at both 1-month and 3-month follow ups. These outcomes are consistent with prior research on caregiver PECS training (e.g., Park et al., 2011; study one) and with the PECS literature surrounding child outcomes (e.g. Flippin et al., 2010; Ganz et al., 2012). Additionally, the inclusion of analyses specifically evaluating skill maintenance is a unique contribution to the PECS caregiver training literature, as much prior research has failed to report on child or caregiver skill maintenance, and those that do have generally conducted follow-ups at shorter intervals or did not evaluate caregiver implementation directly (e.g., Jurgens et al., 2018; Treszl et al., 2021).

Child variables including intellectual functioning, adaptive functioning, autism symptom severity, and pre-requisite skills, which were assessed prior to implementation of the PECSperts Caregiver Training package, were not significantly associated with child PECS use accuracy. This result is inconsistent with the limited extant literature on child developmental/cognitive level and its relation to PECS use (e.g., Koudys, 2011; Pascoe & Tohill, 2011); however, it is consistent with the official Pyramid Educational Consultants position that children do not require any prerequisite skills to successfully learn PECS (Frost & Bondy, 2002). A larger sample size is required to adequately address this research question. A larger sample size may also increase the variability in scores on both the MSEL and ABAS. Only four children had a median age equivalent score on the MSEL at or above 16 months, which was previously identified as a cut-off for acquiring later phases of PECS (Pasco & Toehill, 2011). Similarly, child ABAS-3 scores were generally around the minimum of the assessment measure, thus limiting the variance in these scores.

Parent reported autism symptom severity (AIM total scores) declined significantly from pre- to post-intervention. This decline in total score met the clinically significant threshold of 4.5 points (Mazurek et al., 2020) for six of seven participants who completed the AIM at timepoint 1and 3. This result is surprising because PECS does not explicitly target the core symptoms of autism (Frost & Bondy, 2002). Very few studies have evaluated the effects of PECS on the core symptoms of autism, but this result is consistent with the findings of Lerna et al. (2012)), which found that children who were taught to use PECS had higher scores on the social domain of the Vineland Adaptive Behaviour Scales (based on parent-report) at follow-up compared to children who received conventional language therapy. Given the small sample size, we did not analyze the composite scores of the AIM, and thus we cannot comment on social reciprocity scores specifically. It is important to recognize that parent-report measures are, of course, subject to expectancy bias, especially when parents themselves are implementing the intervention. Unfortunately, the CARS-2 was not readministered at T3, which would have allowed for an observationally-based assessment of change in autism symptoms over the course of the intervention. Future research should evaluate this finding further and include both parent reported and objectively observed autism symptom severity measures.

The results of this study build on the growing knowledge base of structured PECS caregiver training interventions (e.g., Treszl et al., 2021) and overcomes several limitations of the prior telehealth iteration of the PECSperts Caregiver Training package (study one). For example, Treszl et al explored both child and caregiver outcomes following participation in a structured caregiver PECS training; however, only one PECS phase was taught. Importantly, the present study evaluated child and caregiver outcomes across four phases of PECS. Relatedly, study one of this dissertation evaluated caregiver outcomes following participation in the PECSperts Caregiver Training; however, child outcomes were not evaluated which limits our understanding of the effectiveness of the training package. The present study addressed this limitation by evaluating both child and caregiver outcomes, thereby increasing our understanding of the benefits of the PECSperts Caregiver Training package for both children and caregivers.

Importantly, caregivers and children underwent a baseline PECS assessment prior to caregivers attending the online PECS Level One training offered by Pyramid Education Consultants. Time 1 assessments allowed us to ascertain caregiver and child skill level prior to any formal intervention. It also allowed us to assess the unique contribution of the PECS Level One training. Caregivers and children uniformly displayed near zero rates of correct responding at T1 and improved their ability to use PECS correctly following the PECS Level One training at T2. It should be noted, however, that at T2 caregivers were not able to implement the protocol to fidelity levels associated with best learning outcomes (i.e., >80% accuracy; Brand et al., 2019; Wallace & Yassine, 2012). Furthermore, T2 assessments had the highest variability in caregiver PECS use accuracy (SD = 24.06) of all PECS phase assessments. This finding has important clinical implications as it demonstrates that, although some caregivers may attain proficiency in

PECS implementation through didactic training alone, many caregivers may not be able to attain appropriate proficiency and may require structured performance-based training (e.g., BST).

The study also demonstrated that beneficial caregiver and child PECS outcomes can be achieved with a time-limited, resource-efficient intervention. In the initial assessment of the PECSperts Caregiver Training package (study one), caregivers rapidly acquired phases 1-3b teaching skills. Most caregivers reached 100% implementation accuracy during the first teaching session for each PECS phase. Based on these results, the PECSperts Caregiver Training package was revised and in study two we were able to reduce the amount of didactic online teaching from approximately 10 hours to 4 hours of instruction. This time was then used to provide 4 hours of in-person caregiver-child coaching during which caregivers received direct support from a mediator while implementing PECS with their children. Taken together, the total time commitment of this hybrid parent training model was 8 hours, compared to the roughly 10 hours of training parents received in the prior iteration (study one). Yet, outcomes for both studies are similar, with all parents demonstrating increased PECS teaching accuracy. Importantly, the current study demonstrated concurrent improvements in child PECS use, with only 4 hours of direct work with child-caregiver dyads. This is an important clinical finding because caregivers of children with autism generally have limited funding with which to access services (Malik-Soni et al., 2021). Therefore, judicious and efficient use of their funding is paramount. Further, in Ontario, caregivers of young children (12 - 48 months) on the autism spectrum are often offered caregiver-mediated interventions in which they are trained to implement an intervention (Government of Ontario, 2023). The updated and expanded PECSperts Caregiver Training package approximates the focus on caregiver training that these government funded models provide; however, the duration of the training and resources required for implementation are markedly less. Note, however, that the PECSperts Caregiver Training package focuses solely on developing a functional communication system.

Limitations and Future Directions

This study presented a variety of challenges which should be addressed in future research. First, the sample size of nine participants presented several issues. It precluded the possibility of building more complex multilevel models which could have assessed random slope effects. Although unable to directly test for random slopes given the limitation of the data, it is possible that with a larger sample size, a random slope model would have indicated meaningful variation in how much children and caregivers improve over time. The sample size also reduced the power to detect the effects of child variables (e.g., median age equivalent on the MSEL, adaptive behaviour composite). A direct replication of the methodology would allow for the data to be pooled, thus increasing the overall sample size and increasing power to detect an effect of child variables on child PECS use.

A second limitation is the absence of a control group. The data presented above represent repeated measures data from one group of participants, all of whom received the intervention package. As such, we are not able to reach conclusions regarding the PECSpert intervention's effects compared to no intervention or other caregiver-mediated interventions. Despite the absence of a control group, the repeated measures, including the placement of T1 assessments and T2 assessments following the PECS Level One training, provide strong evidence that the PECSperts Caregiver Training package did, indeed, result in improvements in both caregiver PECS teaching accuracy and child PECS use. Further, these results were generally maintained at follow-up.

A third limitation of the current study is the missing data. As mentioned prior, multiple caregiver and child participants had missing data at various timepoints. Much of the missing data was from timepoint three, when a recording error occurred with the community agency's overhead recording system. Other missed data was due to COVID-19 related absences. Yet, the missing data could be considered missing-completely-at-random, which did not introduce systematic bias. Future iterations of hybrid caregiver PECS training models should include multiple methods of recording to ensure that there are backup methods of obtaining the required data. While illness-related absence from caregiver online training or caregiver-child coaching sessions did not produce missing data (as the data for this study were based on PECS phase assessments conducted at a later time), it did shift the nature of the training. Specifically, caregiver illness and absence from caregiver online training sessions often resulted in the other caregiver in attendance receiving an individual session. Similarly, absence from caregiver-child coaching sessions required a "make-up" session booked at a different time to cover that week's content. By the end of the PECSperts Caregiver Training, all caregiver-child dyads received all the curriculum regardless of whether they were absent during a regularly scheduled training session.

Despite the limitations noted above, this study is the first to evaluate a hybrid telehealth caregiver training with in-person caregiver-child coaching. It also adds to the literature combining BST and GCT to train caregivers to implement PECS with their children. There are several notable strengths, including the use of multilevel modelling to model intervention efficacy, which allowed for a fine-grained analysis of intervention effects across time and allowed for an analysis of skill maintenance, which is rarely assessed in PECS effectiveness research. The sample also constituted a relatively diverse group of caregivers and children, both ethnically and regarding child sex. Specifically, 44% (*n* = 4) of the children were girls, and 33% of the sample were ethnically diverse. Historically, girls (Nordahl, 2023) and ethnically diverse children (Streinbrenner et al., 2022) have been underrepresented in autism research and various calls have been made to increase their representation in clinical research. The training approaches were also deemed socially acceptable by the caregivers. Social validity is an essential component of caregiver mediated interventions, as it generally enhances the ecological validity of an intervention, increasing the chances of maintenance once formal intervention has ended (Kemmerer et al., 2023).

There are numerous possible avenues for future research to address the limitations of the current study. First, a direct replication of the above-described methodology would help generate a larger sample size to answer questions regarding child and caregiver characteristics and their interaction with PECS outcomes. Future research would benefit from the inclusion of generalization data, specifically, assessment of caregiver PECS teaching accuracy and child PECS use accuracy in the home environment. Another avenue for further research entails the inclusion of a control group. Including a control group of similar children receiving a different intervention or no intervention (such as a wait-list control) would allow for stronger conclusions to be drawn regarding intervention efficacy across time. Similarly, future research should compare the effects of the PECSperts Caregiver Training package to other caregiver mediated early intervention models in terms of functional communication outcomes. Doing so would allow for greater advocacy to include the PECSperts Caregiver Training package as an option for interested caregivers within the Ontario Autism Program specifically, and with families with autistic children generally, and could provide guidance on which intervention models are appropriate for which families.

Conclusion

Following a brief hybrid telehealth in-person coaching intervention, all caregivers and children demonstrated improvements in their ability to use PECS. Caregivers and children showed some improvement in their PECS use following the PECS Level One didactic training alone; however, the largest improvements in caregiver PECS teaching and child PECS use accuracy were seen following the completion of the 4-week PECSperts Caregiver Training. None of the child variables assessed at T1 were significantly associated with child PECS use accuracy; however, parent-reported autism symptom severity declined in a statistical and clinically significant way. Social validity of the intervention was high, with caregivers indicating that they enjoyed the intervention procedures, that they derived benefits from the program, and that they were likely to continue using PECS with their child following the conclusion of the study. Overall, the hybrid caregiver training model appears to be an effective method for improving PECS use in a community sample. Future replication and extension of the methodology could help establish the PECSperts Caregiver Training package as an evidence-based method for establishing communicative repertoires in children without functional communication.

Chapter 4: General Discussion

Summary of Studies and their Findings

This dissertation presented two studies which evaluated the effects of a caregiver training package on caregivers' ability to implement the first four phases of PECS. These studies constitute a progression in the development of a structured caregiver training package, PECSperts. The first study represented the first iteration of the PECSperts Caregiver Training package. This initial evaluation assessed the feasibility, acceptability, as well as outcomes of a telehealth caregiver training package. Given the limited research into BST and GCT delivered through telehealth in general, and with PECS specifically, this study expanded on that literature. This study involved a multiple baseline across behaviours design for six participants, evaluating caregiver PECS teaching accuracy. The results began to build the knowledge base of the PECSperts model and of caregiver PECS training utilizing BST and GCT methods. The second study constituted the second iteration of the PECSperts Caregiver Training package and represented a shift in its delivery. At this time, the training model shifted to include an in-person training component as well as involvement of the caregivers' children to assess their ability to implement PECS with their own child. Assessment of child PECS use accuracy was included in this iteration, as was an expanded baseline assessment. Baseline assessments included a more fulsome psychological and prerequisite skills assessment to obtain cognitive level, adaptive functioning, and autism symptom severity ratings to evaluate whether pre-existing child characteristics were associated with a child's ability to learn PECS. Additionally, study two allowed for an assessment of the effects of each training component individually (i.e., PECS level one training, and the PECSperts Caregiver Training package).

Together, these two studies begin to fill an important gap in the literature around BST and GCT and their use in training PECS mediators both through telehealth, and in-clinic. Further, they provide a detailed account of a standardized caregiver training protocol. Prior research has failed to integrate telehealth training components and utilize a highly standardized procedure when evaluating PECS.

Study One

The first study evaluated the caregiver PECS teaching accuracy of six parents of autistic children who did not have a functional communication system. Over the course of 2 weeks, caregivers attended the Pyramid PECS Level One training as well as telehealth training sessions where they were taught how to implement the first four phases of PECS (phases 1-3b). Telehealth sessions involved the use of BST and GCT which trained caregivers on a wide range of instructional examples, including both correct and incorrect picture exchange scenarios. Caregiver PECS teaching accuracy was assessed at the end of each telehealth session, using roleplay with the mediator (without their child), and caregivers were required to demonstrate 80% or greater proficiency across three trials prior to moving onto the next phase of PECS.

Overall, all six participants learned to implement the first four phases of PECS with greater than 80% accuracy. These results maintained throughout the study, and then again at 1- and 3-month follow-ups. Group analyses revealed that caregiver PECS teaching accuracy improved significantly from baseline to intervention across all phases, and that there was no significant difference between performance in caregiver performance in the intervention and maintenance phases, highlighting that caregivers maintained their skills throughout the study. Caregivers also rated the PECSperts Caregiver Training package as acceptable and reported satisfaction with the procedures and outcomes.

Study Two

Like the first study, the second study evaluated the caregiver PECS teaching accuracy of nine caregivers of children without functional communication. Additionally, the second study evaluated child outcomes and child characteristics associated with PECS use, examining Child PECS use accuracy as an outcome. Over the course of four weeks, caregivers attended the Pyramid PECS Level One training and then received the PECSperts Caregiver Training package which involved two weekly appointments: one telehealth session with another caregiver, and one in-person caregiver-child coaching session. Over these four weeks, caregivers were trained, using BST and GCT, to implement the first four phases of PECS and were coached while working with their child. Caregiver PECS teaching accuracy and Child PECS use accuracy were assessed at five timepoints during structured PECS phase assessments.

Both caregiver and child participants demonstrated significant improvements in their ability to use PECS over the course of the intervention. Specifically, mean caregiver PECS use accuracy improved by 41.17% per timepoint between T1 and T3, constituting an 82% increase in accuracy from T1 to T3. Similarly, mean child PECS use accuracy improved significantly by 34.25% per timepoint from T1 to T3, constituting a 69% increase in accuracy from T1 to T3. There was no significant change in either caregiver PECS teaching accuracy or child PECS use accuracy between T3 and T5, indicating that both caregivers and children maintained treatment gains following the formal conclusion of their involvement in the PECSperts Caregiver Training. Importantly, most caregivers and children reached mastery criteria of all four phases at T5, indicating significant benefit from the PECSperts Caregiver Training package. None of the child characteristics assessed at baseline (i.e., developmental level, adaptive functioning, autism symptom severity, and prerequisite skills) were significantly associated with child PECS use accuracy scores at T3. Interestingly, parent-perceived autism symptom severity (as measured by the AIM total score) declined significantly between T1 and T3 by an average of 28.76 points, which is clinically significant according to guidelines by Mazurek et al. (2020). Caregivers rated the PECSperts procedures as “acceptable”, noting that the caregiver-child coaching sessions were particularly helpful. Six-month follow-up interviews with five participants indicated that they continued using PECS following completion of the study and that their children had moved on to more advanced PECS phases.

Implications

The results of these two studies are complementary and demonstrate that both caregivers and their children can make significant improvements in PECS use following a brief, systematic training package, that involves the use of evidence-based training approaches (i.e., BST, GCT). Specifically, caregivers in study one received roughly 10 hours of training time and caregivers in study two received 8 hours. In both studies, caregivers demonstrated a high level of PECS teaching accuracy, and in study two, children also demonstrated improvement in their ability to use PECS across all four of the phases that were taught following the brief intervention. The relatively short duration of intervention is significant for several reasons, the first being reduced caregiver intervention burden. Caregivers of children with autism and other developmental disabilities report higher levels of caregiver stress and burden than do caregivers of neurotypical children (e.g., Hayes & Watson, 2013; Padden & James, 2017). Further, navigating lengthy, time-intensive interventions, as well as dissatisfaction with these services have been implicated as a source of such stress (Fong et al., 2023). Reducing the overall duration and demands of intervention while preserving therapeutic outcomes is thus a necessity. The PECSperts Caregiver Training package was able to achieve positive caregiver and child outcomes with a relatively short time commitment. In both studies, caregivers did not report increases in stress or discomfort while participating in the training and rated the overall acceptability of the methods highly.

The brief duration of the PECSperts Caregiver Training package is similar or shorter than the current caregiver-mediated early years interventions offered through the OAP. While the duration of each individual program varies, the time commitment associated with these interventions ranges from 6-weeks to 24-weeks (Government of Ontario, 2023). Given the current funding model in the OAP, brief, effective treatments (especially those including caregivers) have become a focus. Judicious use of limited funds on evidence-based treatment approaches is essential for supporting best outcomes for autistic youth in the province. The PECSperts Caregiver Training package is consistent with this model, and pending further evaluation, could provide an effective caregiver-mediated intervention model especially suited for children who do not currently have any functional communication in place, without a focus on vocal language.

Both studies also demonstrated effective applications of telehealth interventions. Study one implemented a fully telehealth training model while study two utilized a hybrid model, integrating in-person training. Prior to the COVID-19 pandemic, telehealth service delivery had begun receiving increased research attention for autism service delivery (e.g., Ferguson et al., 2018; Sutherland et al., 2018). Following the COVID-19 pandemic, a greater sense of urgency was placed on the development and assessment of telehealth intervention models to ensure continuity of care (e.g., de Nocker and Toolan, 2023; Elison et al., 2021). Prior research has indicated that telehealth increases the accessibility of services, reduces the cost and time investment required to implement services, and has efficacy comparable to in-person interventions (de Nocker & Toolan, 2023).

The present studies expand on this literature and helps address addresses a significant gap around telehealth and PECS training more specifically. The results indicate that telehealth training models are effective for teaching caregivers how to implement the first four phases of PECS. Further, participants in both studies rated the telehealth components of the intervention as highly acceptable. However, participants in study two felt that the in-person caregiver-child coaching sessions were essential for their success with PECS. Study one did not include in-person caregiver-child coaching sessions, and involved caregivers demonstrating their skills based on predetermined scenarios without their child present. It is unclear whether caregivers would rate telehealth caregiver-child coaching sessions as highly as in-person sessions. High participant satisfaction with the in-person component of study two also speaks to the importance of providing service delivery options which meet the needs of those receiving service. The use of telehealth technology brings the PECSperts Caregiver Training package in line with other OAP caregiver-mediated early years programs, which generally involve a blend of telehealth and in-person care.

General Limitations and Future Directions

This dissertation has several limitations. The first limitation is the small sample sizes of both studies ($N = 6$ and $N = 9$). The small sample size affects the generalizability of these results to other caregivers of children with autism. The small sample size in study two reduced the overall variability which may have increased our Type II error rate, especially around child characteristics and their influence on PECS outcomes. Prior research has indicated that a child's cognitive level is generally associated with their PECS outcomes (Koudys et al., 2023; Pasco & Tohill, 2011). Future replications should include a larger sample size.

A second general limitation is self-selection bias. Although we endeavoured to recruit diverse samples, representative of the community in which we ran the studies, the self-selection of our participants must be considered. Study one occurred virtually over the course of two weeks, and study two occurred both virtually and in-person over the course of four weeks. Both studies required considerable, but time-limited caregiver involvement and commitment, with multiple appointments over the span of multiple weeks. Additionally, caregivers underwent assessments at various timepoints, including at one- and three-month follow-ups, further extending their involvement. While study one did not have any attrition, two participants did not participate in the one- and three-month follow-up assessments. Study two had an attrition of four participants, with one additional participant ending their involvement after the T3 assessment. It is unclear to what extent participants who terminated their participation early or who dropped out prior to the beginning of the intervention differed from those who participated in the intervention and completed the one- and three-month follow-ups. Future research should reduce barriers to participation by providing video conferencing hardware to participants (if needed) and by providing accessible in-person appointments, whether that be in-home or at a location closer to participants' place of residence.

Similarly, although study two was relatively diverse in terms of participant sex and ethnicity, study one was relatively homogenous, with all participants identifying as white. The homogenous nature of study one limits its generalizability to diverse populations. Future research should explicitly attempt to recruit widely and encourage participation from individuals who have historically been underrepresented in the empirical literature (Maye et al., 2021).

Additionally, recruitment could be conducted in collaboration with various community agencies who provide service to a diverse clientele. The use of telehealth technology and collaboration with community agencies would allow for more diverse recruitment geographically, racially, and ethnically, enhancing the generalizability of the results.

Conclusion

The two studies presented in this dissertation represent the initial evaluations of the PECSperts Caregiver Training package. These preliminary investigations provided support for the effectiveness of both telehealth and hybrid iterations of the package in improving caregiver and child PECS use outcomes. They also add to the growing research base on the use of telehealth, BST, and GCT in PECS training, as well as to the limited studies evaluating the contribution of child variables to PECS outcomes. Following the conclusion of the second study, the research team has continued to evaluate the PECSperts Caregiver Training package and has begun to amass evidence for its effectiveness. More recent evaluations have also included changes to the package's format, including a summer camp model, as well as telehealth caregiver-child coaching sessions, all of which have maintained the package's brevity, and inclusion of parent training. With continued research into the most effective methodology, as well as replication of these methodologies, we hope that the PECSperts Caregiver Training package will accumulate the research support necessary to be considered an evidence-based practice for children with autism and other developmental disabilities with significant communication impairment. With this level of empirical support, we hope that the PECSperts Caregiver Training package can be offered to caregivers and children in Ontario as part of the OAP, thus enhancing the reach and impact of PECS in improving outcomes for autistic children.

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