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Christopher M. Furlow
Canopy Children's Solutions, christopher.furlow@mycanopy.org

Laura K. Barker
Canopy Children's Solutions, laura.barker@mycanopy.org

Robyn R. Brewer
Canopy Children's Solutions, robyn.brewer@mycanopy.org

Mary N. Thomason
Canopy Children's Solutions, mary.thomason@mycanopy.org

Alexandra G. Brunner
Canopy Children's Solutions, alexandra.brunner.10@gmail.com

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Authors

Christopher M. Furlow, Laura K. Barker, Robyn R. Brewer, Mary N. Thomason, Alexandra G. Brunner, and Frances K. Huff

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Abstract

The current study describes outcomes for seven families who participated in telehealth services from an early intervention clinic in a rural state during the COVID-19 pandemic. Families received different levels of care from a Board-Certified Behavior Analyst (BCBA®) over three months, ranging from one hour to 20 hours per week. The telemedicine sessions primarily focused on teaching caregivers to implement protocols that focused on rapport-building (i.e., Time-In [TI]), increasing child compliance with instructions (i.e., Effective Instruction Delivery [EID]), and language acquisition programs selected from the Promoting Emergence of Advanced Knowledge (PEAK) Comprehensive Assessment and Curriculum. At the conclusion of the telemedicine sessions, parents implemented the protocols with high degrees of treatment integrity, and improvements in skill acquisition on a standardized language assessment were observed for children with autism spectrum disorder (ASD). Implications for providing telemedicine services to rural and underserved communities without access to early intervention services and future directions for research are discussed.

Keywords: *Telehealth, Applied Behavior Analysis (ABA), Autism Spectrum Disorder (ASD), Effective Instruction Delivery (EID), Time-In (TI), Parent Training, Skill Acquisition, Rural Communities, Underserved Communities, Early Intervention Services*

Perspectives for the Delivery of Early Intervention Services via Telemedicine in Rural States: Outcomes from the COVID-19 Pandemic

Autism spectrum disorder (ASD) is estimated to affect 1 in 44 children in the United States (Maenner et al., 2021). Empirically supported early intensive behavioral intervention (EIBI) programs that utilize methods from Applied Behavior Analysis (ABA) for the treatment of ASD (Roane et al., 2016) can be difficult to access, especially in rural states. For example, in Mississippi, access to care can be limited due to long waiting lists and the lack of practitioners. Mississippi is a state that is affected by a shortage of ABA practitioners in rural or underserved communities (Belfer & Saxena, 2006). There are an estimated 13,337 children with ASD in Mississippi alone (Mississippi Autism Advisory Committee, 2020). Currently, there are approximately 100 Board Certified Behavior Analysts (BCBAs) with active certification in the state (Behavior Analyst Certification Board, 2021), and approximately 16 agencies providing some level of ABA services in the state (Mississippi Autism Board, 2021). EIBI interventions offer many young children with an ASD diagnosis an opportunity to expand their verbal repertoires and skillsets more rapidly than comparable interventions (Dai et al., 2020). Thus, it is imperative for these children to have access to ABA services (Aishworiya & Kang, 2020). However, with a severe shortage of practitioners to provide medically necessary ABA treatment to children with ASD, many families have little or no access to care.

In addition, many families in these areas must manage expensive travel or equipment costs to obtain timely intervention (Wacker et al., 2013). According to Cidav et al. (2017), costs for children receiving ABA services with the Early Start Denver Model were estimated to be approximately $14,000 more than those receiving community-based ABA services annually. Rodgers et al. (2020) published a systematic review of 20 studies with participants receiving approximately 20-50 hours of individualized, one-on-one

ABA services per week within the United Kingdom. Of the 20 studies reviewed, 15 included individual participant data and estimated that the usual EIBI treatment for a client per lifetime was approximately the equivalent of £189,122 per quality-adjusted life-year.

EIBI is typically described as evidence-based, one-on-one ABA programs for young children. These interventions are individualized under the supervision of a BCBA and include an emphasis on language acquisition, reducing problem behaviors, daily living skills, and parent-training (Mounzer & Stenhoff, 2022). Discrete Trial Training (DTT), Naturalistic Environment Teaching (NET), and token economies are interventions that are often used in EIBI programs (Thomson et al., 2009; Klintwall & Eikeseth, 2014; Gillis & Pence, 2015). Assessments that are commonly used within EIBI programs may include the Brigance Diagnostic Comprehensive Inventory of Behavior Skills-Revised (CIBS-R; Brigance, 1999), Brigance Inventory of Early Development (IED)-II (Brigance, 2004), Verbal Behavior-Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2014), and Vineland Adaptive Behavior Scale (VABS)-III (Sparrow, Cicchetti, & Saulnier, 2016). Of these assessments, Gould et al. (2011) determined that none alone could be used as the basis of a comprehensive EIBI curriculum because they did not encompass a multitude of skills across multiple domains. The Promoting the Emergence of Advanced Knowledge Relational Training System (PEAK; Dixon et al., 2014) is both a standardized assessment and a curriculum guide that can be used in EIBI programs. Though EIBI programs that utilize such assessments and interventions are typically delivered by staff (e.g., Registered Behavior Technicians) supervised by a BCBA in the clinic, home, and community settings, telemedicine provides an alternative treatment delivery model for families in rural communities.

Telehealth is a treatment modality that has been used to increase accessibility across healthcare fields. Also referred to as telemedicine, telehealth allows providers to deliver interventions remotely using communication technology (Bearss et al., 2018a).

There is a rising body of literature supporting parent training via telehealth as an option to help parents act as the primary change agent in their children's individualized treatment plans (Barretto et al., 2006; Gerow et al., 2021; Tsami et al., 2019; Vismara et al., 2013; Wacker et al., 2013). Specifically, the onset of the COVID-19 pandemic has resulted in an emerging literature base on the use of telehealth for treating individuals with ASD through direct therapy and parent-mediated therapy (Roberts et al., 2019; Hao et al., 2021). Interventions via telehealth have been shown to be an effective method for teaching interventions and assessments to caregivers (Ingersoll et al., 2017), but also one that is largely effective in improving several outcomes in early childhood — namely, reducing challenging behavior (e.g., Lindgren et al., 2020) and improving communication skills (e.g., Baharav & Reiser, 2010; Vismara et al., 2013). Based on the current literature base, The Council of Autism Service Providers (CASP; 2021) released suggested guidelines for direct telehealth services provided to children in EIBI programs (ranging from ages 18 months to 5 years old), including minimum prerequisite skills (e.g., basic joint attention skills, basic discrimination skills, ability to follow 1-step instructions, etc.) and advanced prerequisite skills (e.g., tolerating delayed reinforcement, staying in view of the camera, independently joining a telehealth session, etc.). Another key element the CASP discussed in their suggestions for telehealth practices was parental involvement, specifically noting that parental involvement is paramount to successful client outcomes. The CASP guidelines also note the importance of telehealth services in rural and underserved communities, cost-effectiveness for treatment, and the importance of continuity of care for clients in situations such as global pandemics or other unprecedented events.

Parents are often involved in the care their child receives from an EIBI program by practicing many of the same clinic-based protocols with their child at home. Previous studies have utilized behavioral skills training (BST) either in-person or via telehealth to train parents to implement ABA protocols. In many telemedicine programs,

parents essentially serve in the role of the therapist, providing direct treatment to their children, while the BCBA's are responsible for developing protocols, training the parents, monitoring treatment integrity, and progress monitoring target skills (Boisvert et al., 2010). Some evidence suggests that virtual training programs are successful in establishing the skills necessary to implement ABA protocols. In Fisher et al. (2014), researchers provided preliminary findings of a virtual training program for ABA technicians. The 40-hour virtual training program provided participants with complete e-learning modules for behavior reduction and skill acquisition protocols in discrete-trial and play-based formats. The training program's goal was for the technicians to become proficient in their understanding of ABA principles and procedures used in EIBI so that they could implement them with clients. Participants in this study showed improvements through the reduction of problem behavior as well as improvements in skill acquisition, showing potential for this study to extend access to ABA services to families in rural or underserved areas and populations. Rios et al. (2020) presented results indicating that using BST to conduct functional analyses through telehealth was not only a viable option but one that could be a possible solution for those in rural or underserved areas, a feat LeBlanc and colleagues (2021) described as both important and challenging. Boutain et al. (2020) used BST to train three sets of parents that who demonstrated high levels of fidelity in implementing graduated guidance and then individual completion of self-care skills. Parent training programs provided through telehealth have become increasingly necessary, so much so that researchers such as Yi & Dixon (2021) have developed and evaluated a model for parent training via telehealth that incorporates Acceptance and Commitment Therapy (ACT).

In some cases, telemedicine parent training programs focus on specific assessment methods or skill acquisition treatment protocols, without paying specific attention to rapport building and increasing child compliance. For example, the Research Units in Behavioral

Intervention (RUBI) structured parent training manual (Bearss et al., 2018b) was developed specifically for children with ASD and disruptive behaviors. Some evidence-based antecedent strategies used with children to increase compliance in the presence of a demand are Time-In (TI; Speights Roberts et al., 2008) and Effective Instruction Delivery (EID; Radley & Dart, 2016). Ford et al. (2001) describe TI as social reinforcement that can be either an antecedent or consequence in a child's natural environment. TI uses praise, reflection, imitation, description, and enthusiasm to provide social reinforcement to children as an antecedent strategy, before a child is expected to engage in a certain behavior. The components of EID described by Ford et al. (2001) included making eye contact, being specific and direct, providing only one demand at a time, and allowing a 5-second response time. TI and EID have been used in clinical settings as tools to increase a child's compliance using only positive procedures (Speights-Roberts et al., 2008; Bellipanni et al., 2013; O'Handley et al., 2021). Mandal and colleagues (2000) studied the generalization of TI and EID for achieving child compliance with parents. In this study, using TI and EID alone showed increases in child compliance among participants, but additional increases in compliance were noted when TI and EID were used in conjunction. LaBrot et al. (2022) described the results of a caregiver training using BST to teach TI and EID as being maintained and generalizable to the home setting.

In the present study, a clinic providing EIBI in an ABA clinic to children with ASD in rural areas temporarily suspended in-person services due to the COVID-19 pandemic. Some families receiving services opted to participate in telehealth services while the clinic was closed. Families that continued services via telehealth participated in parent training that specifically focused on protocols for TI, EID, DTT, and NET that were previously used by Registered Behavior Technicians (RBTs) in the clinic setting. BST was used to teach caregivers TI and EID procedures, in order for caregivers to build rapport and achieve higher rates of child compliance before

completing individualized language acquisition protocols. The levels of service were provided depending upon the caregiver's availability to participate in telemedicine sessions. While there have been improved outcomes for parenting skills and communication skills for children with ASD when telemedicine services are provided for as little as 1 hour per week for 12 weeks (Vismara et al., 2009), to our knowledge, no current literature has assessed outcomes for families that participate in more intensive telemedicine programs. The purpose of this study was to explore the effects of caregiver-led telemedicine sessions on the acquisition of language skills as measured by a standardized language assessment for children with ASD in rural, underserved areas. In addition, this study aimed to investigate the average treatment integrity for each protocol the caregiver implemented over 12 weeks of telemedicine sessions.

Method

Experimental Design

A pre-test, post-test quasi-experimental design was employed to evaluate the improvement in language skills before and after telehealth services, using the PEAK Comprehensive Assessment (PCA). The primary dependent variable was the score achieved by each participant on the PCA. The secondary dependent variable was the average treatment integrity score for each protocol implemented by the participant's caregiver. Since each caregiver met the mastery criterion for the implementation of each protocol, single case design graphs are not included but are available from the primary author upon request.

Materials

PEAK Comprehensive Assessment

The PEAK Comprehensive Assessment (PCA) is an empirically supported assessment system designed to evaluate the existence of, and deficits in, a wide variety of functional, cognitive, and language abilities. As part of a comprehensive ABA assessment

of the participant's skill and language functioning, the PCA was conducted prior to clinic closure and upon return to the clinic setting. A direct and indirect assessment of the Direct Training (PEAK-DT), Generalization (PEAK-G), Equivalence (PEAK-E), and Transformation (PEAK-T) modules were included. Each module of the PCA contains 184 specific skills in the participant's language repertoire, providing a maximum PEAK score for the entire assessment of 736. PEAK PCA assessments were conducted by Board Certified Behavior Analysts (BCBAs) in the Early Intervention Clinic.

The PCA includes two norm-referenced modules, the PEAK-DT and PEAK-G modules. Participant performance for the PEAK-DT module can be compared to the performance of same-age, typically developing peers that range from one to ten years old. The PEAK-DT module focuses on one of the learning processes called contingency-based (or directly trained) learning. Contingency-based learning occurs when responses to questions or instructions are increased by feedback following the participant's response, such as error correction procedures or socially mediated reinforcers. The PEAK-G module compares participant performance to the performance of same-age, typically developing peers that range from one to sixteen years old. The PEAK-G module focuses on the basic principle of behavior that occurs when an individual emits a learned response under different or novel conditions. The PEAK-G module can help identify deficits in generalized skills and provide explicit curriculum programming designed to assist with the development of generalized, flexible, and adaptive language skills.

At present, there are no comparative, normative data by age for the PEAK-E or PEAK-T modules. Instead, participant scores are compared to the overall number of skills that are targeted within each respective module. The primary goal of the PEAK-E module is not only to teach clients to emit directly trained responses but to derive novel responses that have never been directly taught in a variety of different and novel conditions. Stimulus equivalence occurs when a learner provides a correct response to untrained

stimuli. In other words, the learner begins to form relationships among stimuli, formulate response classes, and to generalize information that was previously trained in new, untrained conditions. The PEAK-E module evaluates a learner's current ability to derive stimulus relations across four different patterns of responding: *reflexivity, symmetry, transitivity,* and *equivalence*. The most basic of the derived stimulus relations, the process of making a reflexive relation among stimuli, is simply relating a stimulus to itself. In other words, stimulus A is directly trained with stimulus A, resulting in an (A-A) relation. Within the PEAK-E module, the next derived stimulus relation targeted for treatment is symmetry. Generally speaking, this is the process of making a derived relation in the opposite direction of a trained relation. For example, if one were to directly train stimulus A with stimulus B (i.e., A-B relation), the derivation occurs between the B-A relation. Once deriving symmetrical relations is established in a participant's repertoire, clinicians focus on establishing derived stimulus relations known as transitivity. This occurs when a participant must make a derivation across stimuli such that the two items being related were never paired together during the training history. The final, most complex relation targeted for treatment within the PEAK-E module is equivalence relations. This occurs when stimulus A is directly trained with stimulus B (i.e., A-B relation) and stimulus C (i.e., A-C relation). Then, a derivation occurs between the B-C and C-B relations.

Transformation of stimulus function occurs when relating events in terms of other events transforms the meaning of those events in a relatively permanent way. The PEAK-T module establishes a learner's ability to expressively and receptively relate events in the following relational contexts: coordination, comparison, opposition, distinction, hierarchical, and deictic (perspective-taking). The first and most basic relational context is coordination, which describes various ways in which stimuli may relate as same or equal to each other. Once participants learn this relational context, they can begin to make relations among stimuli when all but one item are the

same. This relational context is known as distinction. The concept of opposition requires that participants acquire skills in the relational contexts of coordination and distinction. For the opposition context, the stimuli must be opposite one another, and at least one aspect of the paired stimuli needs to be distinct. Once the previous relations are mastered, the participant may progress to considerably more abstract hierarchical relations. Hierarchical relations are often stated as "A is an attribute of B" or "A is contained by B" and denotes belongingness between a group of stimuli and a common categorical relation. The relations contained within the deictic relational context family are those that specify a relation in terms of the perspective of the participant. Each of these relational contexts is targeted within each subsection of the PEAK-T module with increasing complexity: Non-arbitrary, Cultural, Arbitrary, and Complex. The non-arbitrary relational contexts are constructed by the utilization of the physical features of the stimuli and the relations among them. In contrast, culturally established relational contexts are not constructed by the physical or formal features of the stimuli but are established by cultural or social conventions that specify the relation between words and the objects they represent. The third level of complexity, arbitrary applicable relational frames, is constructed by utilizing arbitrary words or images and incorporating them into the relations between actual words or stimuli. The final, most complex level that is perhaps the most meaningful of the relational contexts within PEAK-T is the complex transformation of function within relational contexts. This is constructed utilizing arbitrary stimuli and requiring the participant to transform the function of relational skills when presented with a novel verbal problem.

Participants and Setting

Seven clients with a diagnosis of Autism Spectrum Disorder (ASD) and their caregivers served as participants in this study. The participants had received Early Intensive Behavioral Intervention services (EIBI) services from an early intervention clinic in a rural

state prior to the COVID-19 pandemic. However, participants' involvement in the early intervention clinic shifted to telemedicine during the COVID-19 pandemic, due to the stay-at-home order issued by the state's governor. Caregivers met with their child's Board Certified Behavior Analyst (BCBA) for parent training sessions conducted in their homes via telemedicine for the duration of time that the clinic was closed, for approximately 12 weeks. At the time the clinic closed, each of the BCBAs had been certified by the Behavior Analyst Certification Board (BACB) and licensed to practice within the state for between two and three years. BCBAs had varying levels of experience with conducting therapy in an early intervention setting prior to becoming a BCBA. One BCBA had been an RBT for two years, one BCBA had been an RBT for three years, and another BCBA had been an RBT for ten years. BCBAs who were responsible for the supervision of each participant's case collected data prior to clinic closure, over the course of caregiver-led telemedicine sessions, and upon returning to the clinic. Since the BCBAs were responsible for the telemedicine sessions and additional staff were not available to collect data while the clinic was closed, IOA data were not collected.

Participant Details

At the time of the clinic closure, Sadie was four years and five months old. She communicated with others by using the Picture Exchange Communication System (PECS)®. Her PEAK score in the PEAK-DT module was 24, which was 43 points lower than the average score of her typically developing 4-year-old peer group. Sadie's PEAK-G score was not applicable, as a minimum score of 30 in the PEAK-DT module is required before conducting the PEAK-G assessment. Though Sadie's score in PEAK-DT was not high enough to include PEAK-G in the assessment, typically developing four-year-olds score 39 in the PEAK-G module. Sadie did not demonstrate mastery of skills in either PEAK-E or PEAK-T module prior to the clinic shutdown. Prior to the clinic closure,

Sadie's parents mastered the implementation of TI and EID. The parents began working with the behavior analyst on implementing NET protocols and a behavior reduction protocol designed to decrease visual and motor stereotypy. Before the onset of COVID-19, Sadie received 31 hours per week of intensive, 1:1 ABA therapy at an early intervention clinic. She did not receive any additional forms of therapy and was not enrolled in school. Sadie's mother had a high school diploma and was not employed prior to the pandemic. During the clinic closure, Sadie's family participated in 10 hours per week of telemedicine with the BCBA.

Claire was seven years and three months old at the time of the clinic closure. Claire used vocal speech as her method of communication. Claire's most recent assessment prior to clinic closure had been completed while she was six years old. Thus, her performance was compared to her typically developing six-year-old peers. Her PEAK skill set in the DT Module was 146, exceeding her typically developing 6-year-old peer group by 1. Claire's PEAK-G skill set was 78, which exceeded the score of her typically developing peers by three. Although her scores exceeded the expectations of her typically developing peer group in the PEAK-DT and PEAK-G modules, her derived relational responding skills were limited and warranted additional treatment. Claire's skill set in the PEAK- E module was 24, and in the PEAK-T module, it was 23. Prior to the clinic closure, Claire's mother mastered the implementation of TI and EID and began working on NET programs. Claire's mother participated in two hours per week of telemedicine therapy during the clinic closure. Prior to the pandemic, Claire received 8 hours of intensive, 1:1 ABA therapy and 8 hours of group ABA therapy at the early intervention clinic. She did not receive additional forms of therapy but received school instruction via distance learning during the shelter-in-place orders. Claire's mother had a college degree and worked full-time before the pandemic.

Cora was five years and two months old at the time of the clinic closure. Cora used vocal speech as her method of communication.

Her PEAK-DT module skill set was 48, which was 97 points lower than the average score of her typically developing 5-year-old peer group. Cora's PEAK-G score was 8, which was 51 points lower than the average score of her typically developing 5-year-old peer group. Cora scored a three in the PEAK-E and PEAK-T module. Prior to the clinic closure, Cora's mother mastered the implementation of TI and EID and began working on NET implementation. Cora's mother participated in 10 hours per week of telemedicine therapy while the clinic was closed. Prior to the pandemic, Cora received 29 hours of intensive, 1:1 ABA therapy at the early intervention clinic. She was not enrolled in school and did not receive additional forms of therapy during the study. Cora's mother had a college degree but was unemployed during the onset of COVID-19.

At the time of clinic closure, Kayla was three years and seven months old. She used vocal speech as her method of communication. Her PEAK-DT score was 65, which was two points lower than the average score of her typically developing 3-year-old peer group. Kayla's Generalization score was 24, which was nine points lower than the average score of her typically developing 3-year-old peer group. Kayla's PEAK-E and PEAK-T score was four. Prior to the clinic closure, Kayla's mother mastered the implementation of TI and EID and began working on implementing NET protocols. Kayla's mother participated in 10 hours per week of telemedicine therapy over the 12 weeks the clinic was closed. Prior to the pandemic, Kayla received 29 hours of intensive, 1:1 ABA therapy at the early intervention clinic. She was not enrolled in school and did not receive any additional forms of therapy over the course of the study. Kayla's mother had a college degree and worked full-time from home during the clinic closure.

At the time of clinic closure, Nash was six years and one month old. He used vocal approximations as his primary way of communicating with others. His PEAK-DT score was 32, which was 113 points lower than the average score of his typically developing 6-year-old peer group. His PEAK-G score was seven, which was 51

points lower than the average score of his typically developing 6-year-old peer group. Nash's PEAK-E score was three, and his PEAK-T score was two. Prior to the clinic closure, Nash's mother mastered the implementation of TI and EID and began working on implementing NET protocols. Nash's mother participated in 10 hours per week of telemedicine therapy during the clinic closure. Prior to the pandemic, Nash received 29 hours of intensive, 1:1 ABA therapy. He was not enrolled in school and did not receive any additional forms of therapy. Nash's mother had a college degree but was unemployed at the onset of the pandemic.

Jack was three years and ten months old at the time of the clinic closure. Jack used PECS® and a limited number of vocal approximations for highly preferred items (e.g., chips). Jack's PEAK-DT score was 9, which was 58 points lower than the average score of his typically developing 3-year-old peer group. For the PEAK-G module, Jack scored 0, which was 39 points lower than the average score of his typically developing 3-year-old peer group. Jack's score for the PEAK-E module was two and for the PEAK-T module was one. Prior to the clinic closure, Jack's mother was working on establishing TI skills and EID. Jack's mother participated in one hour per week of telemedicine therapy. Prior to the pandemic, Jack received 23 hours per week of intensive, 1:1 ABA therapy, and he was not enrolled in school. He did not receive any additional forms of therapy over the course of this study. Jack's mother had an associate's degree and was unemployed at the onset of the COVID-19 pandemic.

Anna was four years and seven months old at the time of the clinic closure. Anna used PECS® for preferred items and American Sign Language (ASL) (e.g., help, more, play). Anna's PEAK-DT score was 27, which was 13 points lower than the average score of her typically developing 4-year-old peer group. Anna's PEAK-G score was zero, which was 39 points lower than the average score of her typically developing peers. For PEAK-E, Anna scored three, and for PEAK-T, her score was two. Prior to the clinic closure, Anna's mother mastered the implementation of TI and EID and began working on

NET implementation, specifically demands (i.e., requests), as well as discrete trials training (PEAK protocol implementation). Anna's mother participated in 20 hours per week of telemedicine therapy over the course of 12 weeks. Before the pandemic, Anna received 29 hours per week of intensive, 1:1 ABA therapy and was not enrolled in school. She did not receive any additional forms of therapy over the course of this study. Anna's mother had a high school diploma and was unemployed at the onset of the COVID-19 pandemic.

Procedures

Behavioral Skills Training

Behavioral Skills Training (BST; Koegel, Russo, & Rincover, 1977) is an empirically supported training method that consists of a didactic presentation, modeling, rehearsal, and corrective feedback on the targeted skill. Each BCBA verbally reviewed each targeted skill with the participant's caregiver. Then, the BCBA provided a video model demonstrating the correct implementation of the skill and role-played the skill with the caregiver. Finally, the BCBA observed the parent implement the targeted skill with the participant. Contingent on incorrect delivery of or missed opportunity to engage in the targeted skills, the BCBA would deliver corrective feedback until treatment integrity reached the mastery criterion.

Behavioral Skills Training was employed during telehealth sessions to teach a variety of protocols necessary to complete a therapy session, such as establishing rapport, procedures designed to increase compliance with instructions, and managing schedules of reinforcement. Parents were directly taught to implement these skills throughout the course of telehealth services using the following protocols: Time-in (TI), Effective Instruction Delivery (EID), Discrete Trial Training (DTT) with token economies, and Naturalistic Environment Teaching (NET). It should be noted that some caregivers had met mastery criteria for TI and EID in the clinic setting prior to telehealth services. Though the caregivers may have previously met mastery criteria for these protocols during contrived sessions in a

clinic setting, data were not yet collected on the protocols in a less contrived, naturalistic home setting. At the time of clinic closure, it was unclear if the caregiver would generalize the targeted skills to the home setting. Thus, the implementation of TI and EID was evaluated through telemedicine following clinic closure to assess the generalization and maintenance of key components of the protocols (e.g., TI and EID) before training caregivers on implementing DTT and NET for specific language and skill acquisition protocols.

Time-In

Time-In (TI; Mandal et al., 2000), often identified in the literature as "pairing," is an evidence-based procedure used to establish rapport between caregivers and their children. Time-in has demonstrated effectiveness in decreasing inappropriate behavior and increasing the value of socially mediated attention provided by caregivers. Time-in consists of five skills, known as the acronym "PRIDE": Praise, Reflection, Imitation, Description, and Enthusiasm. Caregivers were taught to avoid general praise statements (i.e. "good job") and instead, provide enthusiastic praise for specific appropriate behaviors. For example, a caregiver may provide behavior-specific praise for the child cleaning up toys by saying, "Great job putting your cars back in the box!" Caregivers were also taught to reinforce their child's vocalizations by reflecting or rephrasing, sounds, words, or statements. For example, a child may say "Red!" and the caregiver would respond, "That is a red car!" In addition to praise and reflection, caregivers were taught to imitate what their child was doing. For example, if their child was stacking blocks, the caregiver would sit beside them, stacking a different set of blocks. While imitating the child's play, caregivers were also taught to verbally describe what the child was doing. For example, if the child was coloring, the caregiver would say, "It looks like you are drawing a star!" Caregivers were also taught to avoid presenting demands during time-in. For example, if a caregiver asked their child a question (e.g. "What color is this?") during TI, they

were provided with in-vivo corrective feedback to rephrase their question into a description (e.g., "This is a red block!"). Caregivers were taught to gauge the effectiveness of their enthusiasm and genuine delivery of time-in by observing their child's approach behaviors, such as making eye contact with caregiver, smiling, and making physical contact.

Effective Instruction Delivery (EID)

Effective Instruction Delivery (EID; Mandal et al., 2000), often identified in the literature as three-step guided compliance, is an evidence-based approach to establishing consistent compliance from the child in the presence of demands. Guidelines of EID include: saying the child's name, gaining eye contact, delivering the demand within close proximity of the child, delivering the demand as a directive and descriptive statement (i.e. "Pick up the crayons" vs. "Can you pick up the crayons?"), and maintaining a 5-second wait period for the child's response between prompting. As a part of EID, caregivers were trained on how to implement a least-to-most prompting hierarchy to gain compliance from the child. Caregivers were trained to first present the demand. If the child complied with the demand within five seconds, caregivers were trained to provide enthusiastic behavior-specific praise (and sometimes access to a tangible reinforcer). If the child did not comply within five seconds, caregivers were trained to re-present the demand while also modeling the correct response. This was known as a gestural prompt. If the child complied within five seconds of the gestural prompt, caregivers were trained to provide praise alone (no tangible reinforcer) that was not as enthusiastic as if the participant provided independent compliance. If the child did not comply with the gestural prompt within 5 seconds of presentation, the caregivers were trained to re-present the command while also using gentle hand-over-hand guidance to complete the task. No praise was provided for this level of prompt.

Discrete Trial Training (DTT)

Discrete Trial Training (DTT; Anderson et al., 1996) is a structured approach to teaching new skills by directly reinforcing correct responses in the presence of an instruction. DTT is a method of teaching a targeted skill in simplified and structured steps, in which there is a clearly defined beginning and end to each trial. The primary technique used throughout the DTT method of instruction, regardless of target skill, consists of four parts: a) the caregiver's presentation of stimuli to which the participant responds, b) the participant's response, c) the consequence (i.e., various forms of reinforcement or error correction procedures), and d) an intertrial interval (i.e., short pause prior to the next command). Caregivers were initially trained to implement DTT protocols in the home setting that focused on skills from the foundational learning skills within the PEAK DT module (i.e., instructional control, eye contact, joint attention, and scanning a stimulus array). DTT protocols often utilized EID least-to-most prompting guidelines before more complex prompting procedures were utilized, to ensure that participants acquired targeted skills. Before implementing a token economy with their child, caregivers were instructed to provide reinforcement on a continuous reinforcement schedule using the EID least-to-most prompting guidelines (i.e., social praise and tangible reinforcer for independent correct responding, praise after prompted response, new teaching trial after fully guided response). Token Economies are based on behavior analytic principles that emphasize the use of generalized conditioned reinforcement to establish behavior change. Caregivers were trained on three components of the token economy: a) the target response, b) delivery of the token within one second of the participant independently providing the target response, and c) the backup reinforcer after receiving a pre-determined number of tokens according to their child's individualized scheduled of reinforcement. For example, contingent on a participant correctly responding "Red" in the presence of the instruction "What color

is it?" the caregiver would provide the participant with a token. Thinning participant reinforcement schedules (i.e., increasing the number of tokens required before a backup reinforcer was provided) were determined by the behavior analyst.

Naturalistic Environment Teaching (NET)

Naturalistic Environment Teaching (NET; Rule, Losardo, Dinnebeil, Kaiser, & Rowland, 1998) is an evidence-based approach to instruction led by the child in the natural environment during naturally occurring activities (e.g., while the child is playing with preferred items). Caregivers were trained to follow several principles of NET: a) the caregiver follows the child's lead, b) the activities that provide the context for the intervention are child-led, and c) the language acquisition targets that are chosen address skills needed by the child (i.e., skill deficits), d) the caregiver is responsive to the participant's communicative attempts. For example, if the child is playing with toy blocks, the caregiver could contrive an opportunity to teach colors using the blocks. Similar to EID, NET protocols utilized least-to-most prompting guidelines to provide opportunities for skill acquisition to occur. NET skills were determined based on caregiver goals and skill previously targeted in the clinic setting (e.g. vocal mands).

Data Collection and Treatment Integrity

The PCA was administered by the BCBA responsible for the clinical care of each participant. The PCA includes a standardized method of presenting test items and directly testing the language skills located within the PEAK modules (e.g., PEAK-DT and PEAK-G). The pre-test PCA was administered prior to the onset of the COVID-19 pandemic, and the post-test PCA was administered before the participant returned to the clinic for therapy once the clinic was reopened. Data were collected via telemedicine for protocols that were implemented by caregivers. TI sessions were ten minutes in

duration, and data were collected using a partial interval recording method with 10 second intervals. The mastery criterion for TI was 80-100% intervals with at least one of the five PRIDE skills across three consecutive sessions. An EID session consisted of ten discrete instructions provided by the caregiver. The mastery criterion for EID was a treatment integrity score of 80-100% correct across three consecutive sessions. The mastery criterion for DTT and NET was 80-100% treatment integrity across three consecutive sessions. Similar to EID sessions, DTT and NET sessions consisted of ten trials provided by the caregiver.

Data Analysis

Pre-Test and Post-Test PEAK PCA data were analyzed by examining the total number of skills that were acquired across each module of the assessment. In addition, a standardized mean difference (SMD) effect size was calculated for the pre-test and post-test scores for each of the PEAK modules within the PCA and the total PCA score. Effect size results were interpreted according to Lakens (2013): small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$). Average treatment integrity scores were calculated for each protocol implemented during caregiver-led telemedicine sessions.

Results

PEAK Comprehensive Assessment (PCA)

Overall, the total score for each participant's PEAK PCA language assessment score increased following 12 weeks of telemedicine sessions completed by caregivers. The results of the total number of language skills that were acquired as measured by the PEAK PCA are presented in Table 1. On average, the participants acquired a total of 34 specific language skills (range: 18-58) outlined in the PEAK language curriculum. More specifically, participants acquired the highest number of language skills within the PEAK-DT

module (*M* = 21, range: 13-42) and the lowest number of skills in the PEAK-E (*M* = 1, range: 1-5) and PEAK-T modules (*M* = 1, range 1-3). Claire, who had the highest pre-test PEAK PCA score, acquired 44 new language skills over the course of the caregiver-led telemedicine sessions. It may be important to note that Claire had the highest scores within the PEAK-E and PEAK-T modules relative to other participants. Cora acquired 58 new language skills over the course of telemedicine sessions, which was the greatest improvement in language skills relative to other participants in the study. It is important to note that Anna, Cora, and Sadie acquired enough skills within the PEAK-DT module that allowed for the beginning of the PEAK-G module over the course of telemedicine sessions. This module had not previously been introduced to any of these children. In contrast, Jack had the lowest pre-test PCA score with one skill in his repertoire prior to clinic closure, yet he acquired 19 new language skills over the course of caregiver-led telemedicine sessions.

The pre-test and post-test scores for each module are presented in Table 2, and the total PCA scores are presented in Table 2 and Figure1. On average, participants showed the greatest changes in scores within the PEAK-DT module. The average pre-test score for this module was 44, and the average post-test score was 65. This resulted in an effect size that is a small to medium effect (Cohen's $d = 0.44$). In addition, participants showed changes in the PEAK-G module with an average pre-test score of 18 and an average post-test score of 31. This resulted in a small to medium effect size (Cohen's $d = 0.37$). The PEAK-E and PEAK-T modules had an average change in score by 1. This resulted in small effect sizes for the PEAK-E module (Cohen's $d = 0.17$) and the PEAK-T module (Cohen's $d = 0.16$). Overall, the average pre-test total PEAK PCA score was 69 and the average post-test score was 104, which results in a small to medium effect size (Cohen's $d = 0.36$).

Table 1

Language Skills Acquired Following Caregiver-led Telemedicine Sessions

Participant	PEAK PCA Module				
	Direct Training	Generalization	Equivalence	Transformation	Total
Anna[a]	17	11	1	1	30
Cora[a]	42	8	5	3	58
Claire	16	26	1	1	44
Kayla	13	13	0	3	29
Jack	15	-	2	1	18
Nash	19	10	0	0	29
Sadie[a]	25	7	1	0	33
Average	21	13	1	1	34

[a] Reflects participants who began skill acquisition programs with their caregiver during telehealth due to the number of skills mastered within the Direct Training module.

Table 2

Participant Pre-Test and Post-Test PEAK scores

	PEAK PCA Module									
Participant	Direct Training		Generalization		Equivalence		Transformation		Total PCA Score	
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
Anna[a]	27	44	0	11	3	4	2	3	32	62
Cora[a]	12	54	0	8	0	5	0	3	12	70
Claire	146	162	78	104	24	25	23	24	271	315
Kayla	65	78	24	37	4	4	3	6	96	125
Jack	1	16	-	-	0	2	0	1	1	19
Nash	32	51	7	17	3	3	2	2	44	73
Sadie[a]	24	49	0	7	2	3	2	2	28	61
M	44	65	18	31	5	7	5	6	69	104
Range	1-146	16-162	0-78	7-104	0-24	2-25	0-23	1-24	1-271	19-315
SD	49	46	31	38	8	8	8	8	94	98
Cohen's *d*		0.44		0.37		0.17		0.16		0.36

Note. This table reflects each participant's PEAK score prior to clinic closure and upon reopening the clinic. Jack did not achieve a DT score to warrant assessment in the Generalization module.

[a] Reflects participants who began skill acquisition programs with their caregiver during telehealth due to the number of skills mastered within the Direct Training module.

Parent Treatment Integrity

Time In

The results for the implementation of TI with each caregiver are listed in Table 3. On average, all of the caregivers demonstrated correct implementation of TI skills for 94% of the observation across the 12 weeks of telemedicine sessions. Average treatment integrity scores for TI ranged from 82.76% - 100% of intervals in which caregivers demonstrated at least one of the PRIDE skills. Cora's caregiver received the lowest average treatment integrity score relative to other caregivers and often received corrective feedback from the BCBA to increase the rates of praise, reflection, and description components of TI.

EID

The results for the implementation of EID with each caregiver are listed in Table 3. On average, all of the caregivers correctly implemented EID procedures for 88% of the caregiver-implemented treatment sessions. Average treatment integrity scores for EID ranged from 66.87% - 100% correct. Kayla and Jack's caregivers demonstrated the lowest average treatment integrity, with scores of 66.87% correct for Kayla's caregiver and 66% correct for Jack's caregiver. Anecdotally, the lower scores were due to errors with delivering different instructions before following through with the least-to-most prompting hierarchy if the participant demonstrated challenging behavior.

DTT

The results for the implementation of DTT with each caregiver are listed in Table 3. On average, all caregivers correctly implemented the DTT protocols 99% of the time, the highest average treatment integrity relative to other treatment protocols. Average treatment integrity scores for DTT protocols ranged from 97.43% - 100% correct. Jack's family did not target DTT or token economies during telemedicine sessions. Thus, there is no score reported for Jack.

Table 3

Average Caregiver Treatment Integrity

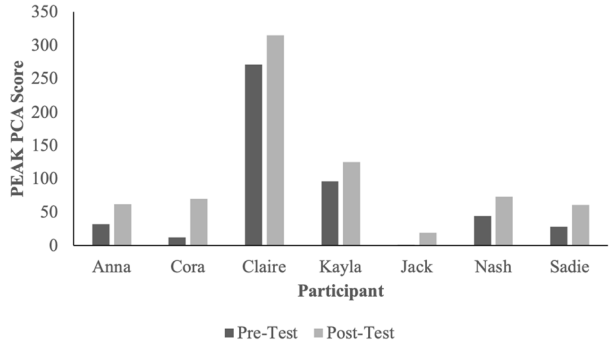
Participant	Treatment Protocol			
	Time-In	EID	NET	DTT
Anna	100%	100%	99.43%	99.21%
Cora	82.76%	100%	85%	100%
Claire	100%	100%	-	100%
Kayla	91.11%	66.87%	-	99.36%
Jack	100%	66%	92.25%	-
Nash	89%	99.67%	84.70%	97.43%
Sadie	92.57%	85.24%	-	99.98%
Average	94%	88%	90%	99%

Note. This table demonstrates the average parent treatment integrity for TI, EID, NET, and DTT protocols with each participant over the course of 12 weeks of caregiver-led telemedicine sessions. Caregivers were not trained on protocols that were not targeted with the participant over the course of clinic closure.

Figure 1

Changes in Total PEAK PCA score

Note. The total PEAK PCA score for the Pre-Test (i.e., before clinic closure) and Post-Test (i.e., upon returning to the clinic) are shown for each participant.



NET

The results for the implementation of NET protocols with each caregiver are listed in Table 3. On average, all caregivers participating in NET protocols with their children correctly implemented the

protocols for 90% of the sessions. Average treatment integrity scores for NET protocols ranged from 84.70% - 100% correct. Claire, Kayla, and Sadie did not target language acquisition using NET protocols during telemedicine sessions. Thus, for these children there is no score to report.

Discussion

Access to care that utilizes methods rooted in Applied Behavior Analysis is important for families of children with ASD in rural communities. Without access to care early in their child's development, there may be persistent, pervasive barriers to learning that include delays in language development. For these families, the prohibitive cost of accessing care and the limited numbers of BCBAs distinguishes telemedicine as a lower-cost, evidence-based option for these services. However, a number of questions remain regarding language acquisition outcomes for children and families who participate in telemedicine programs in rural states.

The primary purpose of this study was to explore the effects of caregiver-led telemedicine sessions on the acquisition of language skills for children with ASD in rural, underserved areas. Overall, each of the participants made improvements in their total PCA score following caregiver-led telemedicine sessions, despite individual differences in the pre-test total PCA score and the number of hours of therapy delivered via telemedicine per week. The participants in this study represent children with a wide range of language skills represented by the total PCA score (Range = 1-271) and communication modalities (i.e., vocal speech, PECS®, and ASL). Although there was a low to moderate effect size for the total PCA score across all participants, it is possible that Claire's scores skewed those results due to her high pre-test PCA scores. Before telemedicine sessions began, Claire's PCA score was 271, with Kayla having the next highest score (i.e., 96) relative to other participants. Participants showed the greatest improvements within the PEAK-DT module. While this could have been due to a clinical

focus on targeting skills within this module by caregivers, it is also possible that participants acquired a higher number of skills within this module once they acquired additional skills within the PEAK-E and PEAK-T modules. As suggested by Ming, Moran, and Stewart (2015), if a student can demonstrate derived relational responding of a particular type, then those skills may be used to program lessons for learning new vocabulary and academic skills more efficiently, in addition to rapidly expanding functional communication skills. For example, Cora acquired the most skills within PEAK-DT, PEAK-E, and PEAK-T. It is possible that the derived relational responding skills acquired within PEAK-E and PEAK-T over the course of telemedicine sessions helped to improve her PEAK-DT score beyond the improvements observed with other participants. Besides Cora, Claire acquired more skills than other participants which may have been due to the fact that she had the highest pre-test PCA score and higher pre-test scores in PEAK-E and PEAK-T. It is also possible that the level of parent participation in telemedicine sessions impacted the results. While five of the seven participants received at least 10 hours per week of telemedicine therapy, it is possible that fewer hours of telemedicine impacted the results for Jack. Jack received only 1 hour per week of therapy and acquired the fewest number of skills relative to other participants. In contrast, the five participants that received 10 hours or more of telemedicine therapy per week acquired 29 skills or more (e.g., Anna acquired 30 skills, Cora acquired 58 skills, Kayla acquired 29 skills, Nash acquired 29 skills, and Sadie acquired 33 skills, respectively). While this study did not determine the effects the dosage of telemedicine therapy has on language development in children with ASD, it is possible that these results could provide preliminary evidence that a higher dosage of caregiver-led therapy may provide higher rates of skill acquisition than one might expect in a clinical setting.

The clinical significance of the number of language skills acquired during caregiver-led telemedicine sessions may also be worth noting. These results may provide insight into the approximate

number of skills that may be acquired over telemedicine in which parents receive training on the protocols included in this study, so that parents may serve as the primary interventionists. First, none of the participants experienced a lower total PCA score following the transition from clinic-based services to caregiver-led telemedicine sessions. It is possible that, in some cases, practitioners and caregivers will anticipate that skills do not maintain over time (i.e., skill regression) with children that transition from clinic-based services to caregiver-led sessions in the home, or when therapy hours are reduced from an early intervention program. Instead, the average number of skills acquired over 12 weeks of caregiver-led telemedicine sessions was 34 new skills (range = 18 – 58) for families that participated in the study. In addition to these gains in language development, three of the participants acquired a sufficient number of skills in the PEAK-DT module to warrant intervention within the PEAK-G module over the course of the caregiver-led telemedicine sessions. It is possible that without caregiver-led telemedicine sessions, the participants might not have had the opportunity to receive intervention within the PEAK-G module once they resumed services within the clinic setting. Further, the three participants who began intervention within the PEAK-G module during caregiver-led telemedicine sessions acquired between seven and 11 new skills within the module before returning to the clinic. For these three participants, not only did they begin treatment in the PEAK-G module, they continued to make progress within the module prior to returning to the clinic for the post-test assessment. This may provide initial evidence that participants in rural, underserved areas can progress through a curriculum designed to target language development, such as the PEAK curriculum, via caregiver-led telemedicine sessions.

This study also aimed to investigate the average integrity of each protocol the caregivers implemented over the course of caregiver-led telemedicine sessions. The caregivers who participated in telemedicine sessions were trained to implement multiple

protocols that included TI (i.e., pairing), EID (i.e., Three-Step Guided Compliance), DTT, and NET (as clinically appropriate). Overall, the caregivers demonstrated the ability to implement a combination of these protocols with high, average treatment integrity over the course of an extended period of time, specifically 12 weeks. Anecdotally, Kayla and Jack's caregivers had the most difficulty with maintaining high average treatment integrity with the EID protocol, due to presenting different demands before moving through the prompt hierarchy in response to challenging behavior (e.g., stereotypy). Though Kayla and Jack's caregivers had difficulty with maintaining high levels of treatment integrity for the EID protocol, they were successful with maintaining high levels of treatment integrity for the DTT and NET protocols, which targeted specific language skills that could have contributed to the increase in PCA scores. It may also be worth noting that five of the seven caregivers implemented these protocols with high average treatment integrity for 10 hours or more per week for the duration the clinic was closed. This may provide some initial evidence that caregivers can provide a higher dosage of therapy with sufficient treatment integrity through telemedicine than previous studies have suggested. In addition, the protocols which were implemented by caregivers are different when compared to protocols found in other parent training programs. For example, programs similar to the RUBI program provide training to caregivers on ways to reduce problematic behaviors. While this is important for reducing problematic behaviors that could serve as barriers to learning, it may also be important for clinicians to provide caregivers with training on protocols that would be implemented to foster opportunities for language development beyond functional communication training. Similar to the procedures in this study, it may be beneficial for practitioners to first consider training caregivers on rapport building protocols, such as TI, and compliance training protocols, such as EID, prior to the implementation of more specific language acquisition protocols for children with ASD who do not demonstrate disruptive behaviors

when delivering telemedicine services. Many ABA practitioners have adopted this approach for EIBI programs across the clinic, home, and community settings. Training parents to implement these interventions may promote a social approach and reduce avoidance behaviors prior to discrete-trial instruction (Shillingsburg, Hansen, & Wright, 2018). Since many children with ASD early in their development would require parent-led telemedicine sessions according to the recommendations outlined by The Council of Autism Service Providers (2021), taking this approach may not only lead to fewer problematic behaviors when access to ABA therapy providers are limited, but also to higher rates of language acquisition over the course of a telemedicine intervention.

There were numerous limitations to the study worth noting. First, the interpretation of the results is limited by a lack of experimental control. Since there was a small group of families who elected to participate in telemedicine therapy during the shelter-in-place orders, it is difficult to make comparisons across families who could have received lower or higher dosages of telemedicine treatment, or a control group that did not receive any telemedicine treatment prior to returning to the clinic. Though this study used a quasi-experimental design, it is possible that there were additional factors that might have influenced the results. For example, it is possible that participants with caregivers who had previously mastered protocols in the clinic setting acquired more language over the course of telemedicine sessions. While this is a limitation, the previously mastered protocols were mastered during controlled, contrived sessions within a clinic setting. Caregivers were encouraged to practice the protocols at home once they met the mastery criterion in the clinic setting, but it was unclear if they had implemented the previously mastered protocols with sufficient integrity in the less contrived, natural environment of the home setting. Since the telemedicine sessions were conducted in the home setting as a result of the shelter-in-place orders, BCBAs first conducted observations of the previously mastered protocols, such

as TI and EID, to ensure that caregivers implemented the protocols with sufficient integrity in the home before training caregivers on additional protocols. In addition, caregivers may have continued to practice the skills targeted during telemedicine sessions beyond the observations by supervising BCBAs. This could have increased the rate of skill acquisition during telemedicine sessions resulting in higher PCA scores. An additional limitation of this study involves the discrepancy in amount of therapy provided: two families who received one hour per week of therapy and one family who received 20 hours per week of therapy were compared to four families who participated for 10 hours per week. Because there were participants who spent differing amounts of time receiving therapy, it is difficult to determine the effect higher or lower intensity telemedicine programs may have on language acquisition as measured by a standardized assessment like the PCA. The results from these participants were intentionally included to provide some initial evidence of the outcomes of the PCA. In addition, there were no IOA data collected due to the nature of the clinic closure over the course of the COVID-19 shelter-in-place orders. The BCBAs were solely responsible for the care of the participants and caregivers who received telemedicine services when the clinic closed. This study is also limited by the fact that participants were receiving clinic-based therapy prior to telemedicine. It is possible that the results for participants who received admission to an EIBI program before receiving telemedicine therapy alone would have different outcomes compared to participants who might have received telemedicine only. The participants' prior exposure to protocols such as EID, DTT, and NET from trained therapists in a clinic setting may have impacted their compliance with instructions delivered by their caregivers before telemedicine sessions began. Finally, there were individual differences across participants that limited the interpretation of the results. For example, three participants used PECS® as their primary mode of communication, while other participants used vocal communication. This could have limited

the rate of individuals' language acquisition over the course of the caregiver-led telemedicine sessions and impacted their post-test PCA score. In addition, three of the caregivers in this study did not receive training on the NET protocol, which could have limited participant progress compared to other participants who received training on DTT and NET protocols.

Despite these limitations, the results may provide preliminary evidence for future directions of research. Though there were no notable differences based on the number of hours per week of telemedicine due to the sample size for this study, future studies may investigate the differential effects of the dosage of telemedicine and participant outcomes. The caregiver participation in telemedicine for the participants of this study varied over the course of the 12 weeks the early intervention clinic was closed; some caregivers participated as few as 1 hour per week while others participated 20 hours per week. While nearly half of the caregivers that participated for approximately 10 hours per week, it may be possible that more intensive telemedicine sessions may lead to larger increases in language skills over the course of admission. In addition, practitioners may want to consider the acceptability of higher dosages of caregiver-led telemedicine over the course of 12 weeks. While the clinic was closed due to shelter-in-place orders, some caregivers were available to deliver higher dosages of telemedicine therapy due to fewer or no work hours. Thus, it is possible that other caregivers will not have the ability or find it acceptable to deliver the same dosage of telemedicine therapy as the caregivers did in this study. In addition, future research may investigate the effects of individual differences in language skills, such as communication modality, on the outcomes of caregiver-led telemedicine sessions. Aside from differences across child participants, future research may also investigate the effects of individual caregiver differences, such as education level or occupation, on treatment integrity throughout the admission. While the participants in this study continued to make progress with their language development over the course

of caregiver-led telemedicine sessions, the effects differences across participants and their caregivers might have on long-term outcomes remain unclear.

Families of children with ASD often experience limited availability of ABA providers in rural states, leaving many children without access to early intervention services. With nearly one-fifth of the United States living in rural areas (U.S. Census Bureau, 2010), telemedicine has become a viable, cost-effective option for addressing many of the barriers these families face when attempting to access ABA therapy (Pollard et al., 2017). And it is possible that a primary focus on high treatment integrity for protocols that focus on rapport building, instruction following, and effective teaching practices may lead to improved language development in early childhood. While these results may only provide preliminary evidence that caregiver-led telemedicine sessions in rural states could result in improvements in language development, practitioners may consider programs that provide a hybrid model whereby families initially attend clinic-based services with their child for an initial assessment and parent training, followed by telemedicine sessions once a treatment plan is developed and parents reach mastery of protocols similar to those included in this study. Thus, it is possible that families in areas with limited access to clinic-based or home-based ABA providers may observe progress in their child's language development with parent participation in a telemedicine program. These positive outcomes may be accomplished while simultaneously providing significant cost savings for the family, similar to other models for delivering telemedicine therapy.

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