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Abstract: *The use of evidence-based practices (EBPs) in the child's natural setting is critical for young children with autism spectrum disorder (ASD) to improve communication skills and promote generalization. Yet, to implement EBPs effectively, caregivers often require training. The purpose of this study is to explore the efficacy of behavior skills training (BST) to teach a caregiver to implement a parent-implemented discrete trial training (DTT) intervention in their home. Using a multiple baseline design, one caregiver was taught to implement the intervention focused on three verbal behavior operants. Results demonstrated a functional relation between the BST and caregiver implementation. This study provides a model for therapists and educators working with caregivers to implement communication interventions in the home.*

Lack of or delay in speech is a common concern expressed by caregivers of children with autism spectrum disorder (ASD). Further, young children who exhibit delays in verbal communication are more likely to have behavioral difficulties in both academic and social experiences (Chow et al., 2018). Thus, exploring specific interventions promoting expressive communication for young children with ASD is essential. Additionally, understanding how families can be involved in intervention implementation is recommended by leading early childhood and ASD-related national organizations such as the Division for Early Childhood (DEC-Recommended Practices, 2014) and the National Research Council (NRC, 2001). Thus, researchers need to ensure that effective communication interventions can be implemented by caregivers, in the home. When exploring communications interventions for children with ASD, practitioners often focus on three primary verbal behavior (VB) operants that Skinner first described in 1957: (1) mands: requests (asking for food when hungry), (2) tacts: labels (saying "car" when a car drives by), and (3) intraverbals: words/phrases used when individuals are engaging in conversation or responding meaningfully to the language of others. For young children, an example of an intraverbal behavior is when a child says "spider" after their caregiver sings, "Itsy bitsy. . ." (Skinner, 1957).

Interventions to increase the VB operants have been widely used in the field of ASD instruction. However, research articles tend to focus on one verbal operant at a time (DeSouza et al., 2017) as opposed to providing instruction on the three operants simultaneously. Further, while research has provided evidence that caregivers can implement interventions and improve child outcomes (Nevill et al., 2016), much research related to VB and other effective communication strategies for children with ASD has relied on professionals to implement the interventions in the classroom or clinical environment (Coleman et al., 2020; Steinbrenner et al., 2020). Therefore, research is needed to explore how practitioners can teach children's caregivers to implement effective interventions for children with ASD in their natural environments (e.g., home).

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Evidence Based Practices (EBPs) for Children with ASD

In recent years, there has been a focus on identifying and defining EBPs for children with ASD. Several empirical literature reviews have identified EBPs for this population in reference to academic, behavioral, communication, social, and other skills (e.g., National Autism Center [NAC], 2015; Steinbrenner et al., 2020). Discrete trial training (DTT) is an EBP that has been found effective in improving several outcome areas, including communication for young children with ASD (Steinbrenner et al., 2020). Rooted in applied behavior analysis, DTT uses antecedents and consequences in a carefully arranged manner to improve communication. DTT is commonly used in comprehensive behavioral treatments or intensive early intervention programs for young children (NAC, 2015). However, one limitation associated with DTT is that children may not being able to generalize skills learned into their natural environment (Schreibman et al., 2015). Thus, it is imperative for practitioners who use DTT to help caregivers not only use the effective DTT practices, but also learn how to support children to generalize skills outside of the DTT sessions.

Commonly, DTT is implemented by behavior analysts; however, researchers have found that caregivers can be taught how to implement DTT (Leaf et al., 2019). In a literature review by Leaf and colleagues (2019) the researchers identified 51 studies that aimed to teach students, teachers, therapists, staff, paraprofessionals, instructors, or caregivers how to implement DTT. Of the 51 studies identified, only a small number of these (9) included caregivers. However, parents and caregivers are an important part of a young child's life and frequently are responsible for the day-to-day responsibilities. In parent-implemented interventions (PIIs) caregivers are taught how to implement an intervention by a professional (Steinbrenner et al., 2020). PIIs have been shown effective in children birth to five years in the many areas, including communication (NAC, 2015; Steinbrenner et al., 2020).

Behavior Skills Training (BST)

BST is a widely adopted, evidence-based training method used in the field of behavior analysis that supports behavior analysts as they train staff to implement interventions (Reid et al., 2021). BST typically involves four steps: "instruction, modeling, role-play, feedback" (Schaefer & Andzik, 2020, p. 19). During instruction, the instructor teaches the participant how to implement the targeted skill by defining it using a written description or protocol. Next, the instructor models the skill that they would like the participant to implement with the child (e.g., through the use of video models; Schaefer & Andzik, 2020). Then the participant practices the skill through role-play while the instructor provides supportive and corrective feedback (Parsons et al., 2012).

In a review of literature, Schaefer and Andzik (2020) found that BST is an effective EBP used to support caregivers to complete interventions. The caregivers in the reviewed studies implemented a wide range of interventions, including VB-based and EBPs (e.g., DTT and prompting). However, half of the children in the studies had ASD and half utilized a clinical setting. For example, Loughrey et al. (2014) used BST to teach caregivers skills utilized in mand training (e.g., assessment of and teaching mands). After BST, the three caregivers in the intervention were able to implement the procedures with 80% accuracy, maintain skills learned, and accurately teach their spouses. This intervention was completed in an ASD treatment center located on a university campus. Thus, while there is evidence to support BST being used to teach caregivers of children with ASD to implement VB and EBPs, more research is needed to ensure that caregivers can implement these interventions in their homes.

As referenced, research has provided evidence that BST can be used to effectively teach caregivers to use a parent-implemented DTT. However, this research includes a small number of participants, and many studies are completed in clinical settings (Coleman et al., 2020; Leaf et al., 2019; Schaefer & Andzik, 2020). Research is needed to explore how practitioners can teach children's caregivers to implement effective interventions for children with ASD in their natural environments. While DTT does have limitations, particularly around generalization, it still has utility for teaching discrete skills and lends itself well to

VB operants. After acquisition of the skills, generalization must be addressed.

The goal of this study was to explore the effective use of a caregiver as an interventionist when implementing a highly-structured intervention program in their home. We taught one caregiver how to complete the parent-implemented DTT intervention that incorporated VB and EBPs for children with ASD. We addressed the following research questions: (1) Is there a functional relation between the parent-implemented DTT and the caregiver's implementation of the intervention program targeting mand, tact, and intraverbal instruction? (2) Does the use of the intervention result in socially important outcomes for the caregiver? In addition to these research questions, we also explored child outcomes related to the verbal operants targets. We had also planned to assess generalization and maintenance of the parent-implemented DTT approach and child outcomes; however, COVID-19 restrictions stopped the study prematurely.

Method

Design

This project utilized a single subject, multiple baseline across behaviors design. The design is a practical method for assessing intervention programs targeting multiple behaviors that cannot be reversed after being learned (Gast et al., 2018). This study targeted three functionally independent, yet similar behaviors (mand, tact, and intraverbal).

Participants

The first author trained a graduate student in her final year of the master's in special education program to serve as the data collector and caregiver's coach for this study (henceforth referred to as the coach). This study was conducted with one caregiver and their young child with ASD. Prior to recruitment and participant selection, this study was approved by the university's institutional review board and participants provided informed consent.

The first author recruited the caregiver/child dyad by asking local community disability and early childhood agencies to advertise via social media and email listserv. Interested caregivers contacted a research assistant to express interest in participating. The first two caregiver/child dyads who met the inclusion criteria were asked to participate. To be included in this study, caregivers had to be over the age of 18 years, speak fluent English, and sign consent for themselves and their child. The child in the study had to be between the ages of 2 and 5 years, have a pre-established caregiver-reported diagnosis of ASD, and demonstrate expressive language difficulties. We sought to include two dyads; however, one of the dyads dropped out of the study due to scheduling conflicts. Thus, one caregiver and child participated fully.

Background Assessments. Debbie (pseudonym) was included in this study with her child, Adam (pseudonym). Over the course of two separate days, the research team collected background information in the home by conducting one 60-minute formal observation, a semi-structured 30-minute interview with Debbie, and a modified preference assessment (based on Frost & Bondy, 2002). During the observation and interview, we observed Adam's language abilities (according to the three operants) and interests. We also asked Debbie to describe his interests (i.e., favorite items and songs to serve as the materials), imitation skills, preferred communication, language use, and prior intervention information (e.g., previous parent training, speech language and/or developmental therapies, and preferred methods to elicit language use). The first author completed the *Autism Diagnostic Observation Schedule- Second Edition, Module 1* (ADOS-2; Lord et al., 2012) in the university clinic. The ADOS-2 is a semi-structured assessment tools that provides a standardized measure of behaviors that are associated with ASD. ADOS-2 module one is designed for children 31 months or older who are not yet consistently using "phrase speech" (e.g., spontaneous, meaningful, non-echoed, three-word combinations used to socially communicate or communicate wants/needs). The ADOS-2 measures behaviors related to: (1) social affect (SA): communication (spontaneous vocalizations and non-verbal communication attempts) and reciprocal social interaction (e.g., eye contact, facial expressions, joint attention), and (2) restricted and repetitive behavior (RRB):

e.g., sensory interests, echolalia, and stereotyped behaviors. A certified speech language pathologist (SLP) watched the ADOS-2 assessment video recording to complete the formal speech observation of receptive, expressive, and pragmatic language skills. Once all the background information was gathered, the primary author wrote a formal summary report and shared this with Debbie and Art (pseudonym for dad) to ensure accurate information. The assessment report was also used as an incentive for participation.

Adam. Adam, a White male, was 4 years 3 months old at the start of the study. Adam was diagnosed with ASD and began speech therapy at approximately 18 months. At the time of the study, he attended a private, full-day school and received speech and occupational therapy three times per week. Adam independently communicated via reaching and pulling Debbie's hand to the object he wanted (e.g., door to leave assessment room). He communicated using sounds and word approximations after Debbie modeled the communication. He also allowed Debbie to provide a full physical prompt to communicate via sign language. Adam mostly communicated in the form of mands, e.g., "bababa" for banana, "/a/-/p/-/p/" for apple, and said "no" once. During the home observation, Adam used one tact, "kit kit" (cat), and did not communicate through the use of intraverbals. Overall, Adam's verbal output mainly consisted of consonant-vowel (CV) duplications (e.g., bababa), making assessing his articulation skills difficult. His attempts to communicate were also fleeting when the examiner or Debbie prompted him to communicate in a more complex way. For example, if he reached for an item and the communicative partner modeled the word, he walked or turned away when his request was not rewarded immediately.

The research team also noted Adam's ability to stay engaged during the assessments. During the home observation, Adam stayed near the coach and Debbie for the majority of the time. He stayed attentive in the play opportunities and stayed at the table for the requested amount of time during the preference assessment (approximately 10 minutes). The ADOS-2 was completed in the clinical setting, which was unfamiliar for Adam. For most of the assessment, compared to a child Adam's developmental level, Adam was more active, and it took a lot of effort for the examiner and Debbie to keep him engaged in the activities. When Adam was prompted to sit at a child-sized table, he attempted to elope. Adam's total ADOS-2 overall score was 23 (SA: 19, RRB: 4, range 0 to 28). His comparison score of 8 (range 1 to 10) was calculated by comparing his raw score of 23 compared to his chronological age, and language level (few to no words). This comparison score indicates that Adam displays a high level of ASD-related symptoms.

Debbie. The family (Debbie, Art, Adam, and twin brother, Joey) recently relocated back to the state where Debbie had grown up. Debbie, a White female, has a bachelor's degree and was working part-time. Art also has his bachelor's degree and worked full-time from home. Debbie reported that she received training related to improving Adam's communication skills through early intervention services when Adam was 2 years old. However, she had not previously received ASD-specific or VB training. To prompt Adam to communicate, Debbie stated that she demonstrates language for Adam and will prompt him to communicate by scrolling through several choices (e.g., she will continually ask Adam questions until she can figure out what he wants to eat: "Do you want apple?" "Do you want banana?" "Do you want chips?"). If she can figure out what Adam wants, she will prompt him to repeat the word or might help him sign the word with a physical hand-over-hand prompt. Debbie stated that if Adam makes *any* sound, she will reward him with the requested item. In observation, Debbie did not use a consistent process to prompt Adam to respond; she often repeatedly vocalized the word she wanted him to say without providing response time or a requirement for communication.

Setting and Materials

All sessions occurred in home and were completed sitting at a table/chair with tray. To select the materials needed, the coach completed a preference assessment (modified from Frost & Bondy, 2002) to understand

Adam's most preferred items. The most preferred items, iPad and sparkling water, were originally used for the mand tier, with the words "iPad" and "drink" as the targeted chosen words. Adam was provided chips (another highly preferred item) as a reward for participating in the sessions. When deciding on the items and songs for the tact and intraverbal tiers, we asked Debbie to name items and a song that she would like Adam to label/sing with her. We emphasized that the items should be items that he is familiar with, but not his favorite items. She named "outside" (a picture of the family's backyard) and Adam's shoe, and we chose these items originally for the tact tier, and the song "itsy bitsy spider" for the intraverbal tier.

Dependent Variables and Data Collection

The coach collected data on all dependent variables during each session. Caregiver implementation was the main dependent variable, and the two secondary dependent variables were child outcomes and caregiver competence. We defined *caregiver implementation* as Debbie accurately implementing each of the three intervention tiers as prescribed. In the baseline, we observed behaviors to understand how many times Debbie prompted Adam to communicate and how she did so. Each time Debbie prompted Adam to communicate, we documented whether Debbie's prompt was included in the intervention protocol by marking "Y" for yes or "N" for no. Further, if Debbie completed the first step of the intervention protocol correctly, the coach would then document if she completed the rest of the protocol in the correct order. The coach also wrote anecdotal notes to describe what types of prompts Debbie used. The data collection for the intervention was similar. It was collected on the researcher-developed data sheet (adapted from Coleman, 2018 [see Figures 1, 2, and 3]). There were 15 steps included in the mand and intraverbal instruction tiers, and 14 included in the tact tier. *Child outcomes* were collected on the same data sheet. Debbie prompted Adam to use the following targeted operants: (1) mand: requesting for iPad and drink by saying or signing, (2) tact: labeling outside and shoe by saying or signing, and (3) intraverbals: filling in words/signs when Debbie sang "itsy bitsy spider" by saying or signing. Further, she provided various prompts and models, and the researcher coded Adam's responses. For example, if Debbie provided a verbal prompt, model, sign language, or physical prompt, the coach recorded Adam's response as: prompted, modeled, sign language, or physically prompted, respectively.

Procedure

The average length of each session was 20 to 25 minutes, and they were planned for twice a week. However, the child and/or caregivers were often sick at least one of the scheduled visits each week, thus causing a cancellation. Therefore, out of our 15-week (21 session) study, six of those weeks entailed two sessions.

Baseline Condition. The purpose of the baseline condition was to assess Debbie's ability to prompt for communication and Adam's ability to communicate using the three operants during a typical setting (Gast et al., 2018). During the baseline, Debbie was simply asked to play with Adam as she normally would and prompt him to request, label, and fill in words to the targeted song.

Caregiver Training Sessions. Three training sessions were implemented immediately prior to each intervention tier (e.g., mand training session occurred prior to mand tier, tact training session occurred prior to tact tier after mand was mastered). The mand training sessions lasted approximately 45-minutes and the tact and intraverbal instructional sessions lasted approximately 30 minutes and occurred in Debbie's home.

The model used in this study follows the BST model (Reid et al., 2021). During the training session, the coach followed the protocol developed by the lead author and was instructed to complete each step on the protocol. Specially, the coach reviewed the following documents with Debbie: the intervention protocol, intervention data sheet which listed the protocol steps in an abbreviated format, a visual diagram of the intervention procedures, and a sign language document that listed the signs to be

Participant Numbers:_____ Date: _____
Observer: _____ Session #: _____
Item: _____

Instructions: Steps 1-4: Circle Yes (Y) or No (N) to indicate if caregiver implemented step correctly. **After step 3:** Boxes represent the opportunities required for the item presented. *Caregiver Data*- Write Y, N, or leave blank to indicate not applicable. *Child Data*- place a check in the box that corresponds

	Caregiver Data	Child Data
1. Present 1-3 items (optional: "Look," "What do you want?" or "What would you like to play with?")	1. Y / N	
2. When the child requests, allow brief access to the item.	2. Y / N	
3. Remove other preferred items.	3. Y / N	
Intervention Trial: 4. Caregiver removes item from child	#4	
5. Time Delay- Waits for 3-5 seconds	#5	
6. Child verbally mands- immediate access. **(Independent [I] Mand)**	#6	I
7. Praise & say name of item.	#7	
Error Correction (EC):	EC1	P
1. Caregiver provide verbal prompt ''What do you want?''	EC2	
2. Time Delay **(Prompted [P] Mand)**	EC3	M
3. Caregiver provide verbal model: "[item name]"	EC4	
4. Time Delay **(Modeled [M] Mand)**	EC5	SL
5. Caregiver provide sign language mand & "[item name]"	EC6	
6. Time Delay **(Sign Language [SL] Mand)**	EC7	PP
7. Caregiver physically prompts & "[item name]"	EC8	
8. Allow access to the item. **(Physical Prompt [PP])**		
*Repeat Steps 4-EC until the trial ends.		

*Convert frequency to percentage data: caregiver- 9 out of 10 steps correct: 90%; child- 4 out of 5 independent: 80%. Average all trials to place in excel sheet for session data.
Caregiver Implementation: _____ I: _____ P:_____ M: _____ SL: _____ PP: _____

NOTES:

Figure 1. Data Sheet Tier 1 Mand Instruction.

used with corresponding pictures and a video to illustrate the sign. After reviewing the documents and answering questions, they watched video models and engaged in role play opportunities while the coach provided feedback. To ensure Debbie was prepared to accurately implement the intervention and felt comfortable implementing the intervention with Adam, the coach completed role-play opportunities until Debbie felt comfortable and able to complete the intervention with Adam during the next session.

Parent-implemented DTT. During the three training sessions, the coach taught the caregiver to implement the parent-implemented DTT, a form of PII which included DTT and a VB intervention that targeted verbal or sign

Participant Numbers:_____ Date: _____
Observer: _____ Session #: _____
Item: _____

Instructions: Steps 1-2: Circle Yes (Y) or No (N) to indicate if caregiver implemented step correctly. **After step 2:** Boxes represent the opportunities required for the item presented. *Caregiver Data*- Write Y, N, or leave blank to indicate not applicable. *Child Data*- place a check in the box that corresponds

	Caregiver Data	Child Data
1. Present 1-3 items	1. Y / N	
2. Allow free play for 30s to minute	2. Y / N	
Intervention Trial: 3. Pick item & gain child interest	#3	
4. "What's this?"	#4	
5. Time Delay- Waits for 3-5 seconds	#5	
6. Child verbally tacts- praise & say name of item. **(Independent Tact)**	#6	I
Error Correction (EC):	EC1	
1. Caregiver provide verbal prompt "What's this?"	EC2	P
2. Time Delay **(Prompted Tact)**	EC3	
3. Caregiver provide verbal model: "It's a [ball]! [Ball]!"	EC4	M
4. Time Delay **(Modeled Tact)**	EC5	
5. Caregiver provide sign language & "[item name]"	EC6	SL
6. Time Delay **(Sign Language Tact)**	EC7	
7. Caregiver physically prompts & "[item name]"	EC8	PP
8. Allow access to the item. **(Physical Prompt)**		
*Repeat Steps 3-EC until the trial ends.		

*Convert frequency to percentage data: caregiver- 9 out of 10 steps correct: 90%; child- 4 out of 5 independent: 80%. Average all trials to place in excel sheet for session data.
Caregiver Implementation: _____ I: _____ P:_____ M: _____ SL: _____ PP: _____

NOTES:

Figure 2. Data Sheet Tier 2 Tact Instruction.

language (see Table 1). The coach taught the caregiver how to use VB to target the three operants: mands (requesting for iPad and drink), tacts (labeling outside and shoe), and intraverbals (filling in words/signs when Debbie sang 'itsy bitsy spider'). The parent-implemented DTT also incorporated other effective EBPs in the error correction procedures (e.g., time delay, prompting, and modeling; Steinbrenner et al., 2020). Debbie was taught to use DTT by encouraging Adam to sit at a table and providing multiple (at least four) trials for each item/song targeted. She was instructed to implement the three to five second time delay (TD) procedures first by holding up targeted items and waiting for Adam to respond. Because prompt dependency is often an associated limitation in DTT (Schreibman et al., 2015), Debbie was instructed to provide the time delay first to allow Adam to communicate without prompting. If Adam said or signed the targeted word, Debbie immediately verbally praised and provided access to the item (iPad or drink during mand tier) and/or reinforcement (chips during tact and intraverbal tier). If Adam did not respond verbally or with sign

Participant Numbers:_____ Date: _____
Observer: _____ Session #: _____
Item: _____

Instructions: Steps 1-2: Circle Yes (Y) or No (N) to indicate if caregiver implemented step correctly. **After step 2:** Boxes represent the opportunities required for the item presented. *Caregiver Data*- Write Y, N, or leave blank to indicate not applicable. *Child Data*- place a check in the box that corresponds.

	Caregiver Data	Child Data
1. Present 1-3 items	1. Y / N	
2. Allow free play for 15s-30s	2. Y / N	
Intervention Trial:		
3. Gain child interest (optional: "What to sing a song?")	#3	
4. Sing one of the target songs and pause	#4	
5. Time Delay- Waits for 3-5 seconds	#5	
6. Child uses intraverbal – praise & say intraverbal. **(Independent Intraverbal)**	#6	
7. Continue singing song if **independent**/NA if not	#7	I
Error Correction (EC):		
1. Caregiver provide verbal prompt "/s/" for "Twinkle, twinkle"	EC1	
2. Time Delay **(Prompted Intraverbal)**	EC2	P
3. Caregiver provide verbal model: "Star!"	EC3	
4. Time Delay **(Modeled Intraverbal)**	EC4	M
5. Caregiver provide sign language & intraverbal	EC5	
6. Time Delay **(Sign Language Intraverbal)**	EC6	SL
7. Caregiver physically prompts & intraverbal	EC7	
8. Allow access to the item. **(Physical Prompt)**	EC8	PP
*Repeat Steps 3-EC until the trial ends.		

*Convert frequency to percentage data: caregiver- 9 out of 10 steps correct: 90%; child- 4 out of 5 independent: 80%. Average all trials to place in excel sheet for session data.
Caregiver Implementation: _____ I: _____ P:_____ M: _____ SL: _____ PP: _____

NOTES:

Figure 3. Data Sheet Tier 3 Intraverbal Instruction.

language, Debbie began the error correction procedures which involved a TD after each verbal, sign language, or physical prompt or model (see Table 1). The sign language and physical prompts were built in to encourage an appropriate response if the child was not yet talking (based on the principles of errorless teaching; LaFrance & Miguel, 2014).

Intervention Condition. Throughout the intervention condition, the three tiers (mand, tact, and intraverbal instruction) were introduced in a staggered manner (Gast et al., 2018). Debbie did not introduce tier two or three until stable data were established for the operant's baseline condition, she met the pre-established mastery criterion for the preceding operant's intervention tier (achieved 75% accurate implementation across five consecutive intervention sessions), and stable data were seen in the preceding operant's intervention tier (e.g., at least 3 data

TABLE 1

Intervention Implementation by Tier

Tier & Operant	Child Outcome	Caregiver Implementation
1 Mand	Request for 2 items	1. Caregiver presents one item at a time 2. *Time Delay:* caregiver does not speak, allows child to respond without prompting 3. *Verbal prompt*: "What do you want?" 4. *Verbal model*: "[item?]" 5. *Sing Language prompt*: sign & say the name of the item 6. *Physical prompt*: provide hand-over-hand prompting to sign the name of the item
2 Tact	Label 2 items	1. Caregiver picks up item and says "What's this? 2. *Time Delay* 3. *Verbal prompt*: "What's this?" 4. *Verbal model*: "It's a [item]! [ball]!" 5. *Sing Language prompt*: sign & say the name of the item 6. *Physical prompt*: provide hand-over-hand prompting to sign the name of the item
3 Intraverbal	Fill in words to 1 song sung	1. Caregiver sings "itsy bitsy spider" and stops singing in the middle 2. *Time Delay* 3. *Verbal prompt*: say letter sound of target word, e.g. /s/ for *spider* 4. *Verbal model*: say target word, e.g., *spider* 5. *Sing Language prompt*: sign & say the target word 6. *Physical prompt*: provide hand-over-hand prompting to sign the name of the item

points at the relatively same level). Debbie completed multiple trials with each of the targeted objects/songs; thus, there were on average seven to fifteen trials per intervention tier. For example, during the mand tier, Debbie implemented the mand instruction, on average, seven to 15 times to encourage Adam to ask for iPad and drink (at least four times per item). Debbie was instructed to provide instruction on the operant that was the focus of the tier, and Debbie added additional operant instruction as the study continued. For example, during the mand tier Debbie was instructed to focus on the mand instruction/operant only. After she provided the mand instruction, she engaged in free-play with Adam while the coach took baseline data on the other operants (tact and intraverbal). In the tact tier, Debbie was instructed to focus on the mand and tact instruction/operant. After she provided the mand and tact instruction, she engaged in free-play with Adam while the coach took baseline data on intraverbals.

Reliability and Fidelity

Consistent with single case research design (SCRD) recommendations (Ledford et al., 2018), all sessions were video recorded to allow for data collection to determine fidelity, interobserver agreement (IOA), and ensure the coach was collecting reliable data on caregiver implementation, caregiver competence, and child outcomes. The coach collected the primary data and the lead author was responsible for collecting data used to determine IOA. The lead author also collected data on fidelity to ensure the coach was following the caregiver training implementation protocol and not providing the caregiver prompts during the baseline or intervention sessions.

Fidelity for Caregiver Training Sessions. The first author used self-monitoring to teach the coach to complete the caregiver training sessions with fidelity and collect reliable data by reviewing and then checking off each step listed on the researcher developed 'Caregiver

TABLE 2

IOA for Caregiver Implementation and Child Outcomes

Variable	*Mean*	*Range*
Mand IOA		
Caregiver Implementation	89.49%	75–92.22%
Child Outcomes	95.83%	75–100%
Tact IOA		
Caregiver Implementation	95.88%	86.4–100%
Child Outcomes	100%	
Intraverbal IOA		
Caregiver Implementation	94.65%	84.85–100%
Child Outcomes	100%	
Total		
Caregiver Implementation	93. 34%	75–100%
Child Outcomes	98.61%	75–100%

Training Protocol'. The protocol listed the needed documents and materials the coach would review with the caregiver, the specific instructions needed for the caregiver training, the video models with corresponding directions and prompts, and directions on how to complete the role-play rehearsals. Following BST, the coach and lead author reviewed the instructions together, completed role play practices (to ensure fidelity), and watched the video models to ensure the coach felt comfortable teaching the caregiver how to complete the intervention. During the three caregiver training sessions, the coach utilized self-monitoring by reporting to the lead author that they implemented the training sessions with fidelity by checking off each step listed on the written protocol (i.e., Caregiver Training Protocol).

Fidelity for Baseline and Intervention Sessions. The lead author did not provide instruction on coaching implementation during the baseline and intervention sessions because the caregiver was implementing the intervention. The coach was simply instructed not to intervene with the session unless the caregiver requested help to remember a procedural step. The coach was also instructed to not interrupt the session unless it was to ensure Debbie prompted Adam to use all of the targeted operants or unless Debbie asked a specific question.

Data Collection Reliability. After the training session with the coach, to ensure IOA, the coach independently coded video models on all dependent variables until the coach and lead author gained at least 90% accuracy across three baseline and intervention mand trials. Video models were not available for the tact and intraverbal intervention tiers; instead, they gained 90% accuracy during three role-play practices. Further, because video models were not available for the tact and intraverbal intervention tiers, the lead author determined that during the first baseline session, fidelity and IOA would be collected. The coach and first author coded the first session independently, spoke about the disagreements, and watched the session again to code data together and reach consistency. After the additional practice and discussion, they collected IOA data again until they met the pre-established criterion (75%) during session two (mand = 82.8%, tact =100%, intraverbal = 84.85%).

Fidelity and Reliability Results. During each baseline and intervention session, the lead author collected IOA and fidelity data during at least 36% of the sessions (fidelity collected during 38.9% of sessions and IOA collected during 37.94% of sessions). She collected the data during the first session of each intervention tier to ensure the coach was accurately coding data and implementing with fidelity. Since session 1 was used as a practice session for IOA and fidelity, it was not calculated in the IOA and fidelity results.

When assessing for fidelity during the intervention sessions (e.g., the coach's ability to not intervene with the caregiver implementation), the lead author watched the study sessions to ensure the coach did not provide Debbie with any prompts. The coach consistently did not interrupt the sessions or provide prompts unless Debbie asked; thus, achieving perfect (100%) fidelity scores each session. For both the caregiver implementation and child outcome data, IOA scores did not fall below the predetermined 75% IOA criteria in any of the sessions (x = 95.98%, range = 75% to 100%; see Table 2).

Social Validity

Six weeks after completing the intervention, the lead author conducted a social validity interview with Debbie to determine the practical use of the intervention from her perspective and to understand if she was continuing to us the intervention strategies. The semi-structured interview was approximately 30-minutes long and Debbie was asked questions related to: (a) her current understanding on her child's communication needs and if this understanding is different than what she knew prior to the study, (b) the ease and practicality of implementing the intervention, (c) using the intervention outside of the sessions, and (d) the overall effectiveness for Adam.

Data Analysis

We used visual analysis methods to analyze the caregiver implementation data, which served as the main dependent variable, and the child outcome data (Barton, Lloyd, et al., 2018). For the caregiver implementation data, we determined the overall score that was placed on the graph for visual analysis by converting the event recording data to percentage of accuracy using the equation: (number of Ys ÷ [Ys + Ns]) x 100. We converted the child outcome event recording to percentage of accuracy by dividing the targeted responses (child's use of independent, prompted, or modeled verbal or sign language) by the total number of child responses (targeted plus the physically prompted response) and multiplying by one hundred.

We analyzed the data to determine trends, levels, and stability/variability to evaluate the data in a formative manner and determine the need to introduce the next intervention tier. Trend lines and stability envelopes were calculated using the split-middle method. The stability criterion is 80% (i.e., 80% of the data points were to fall into the stability envelopes that were calculated based on 25% of the trend lines). The envelopes allowed us to calculate how much variability was seen in the data (Barton, Lloyd, et al., 2018). We examined levels by calculating the relative level of change within conditions by subtracting the median value of the first half of the data from the median value of the second half. We also analyzed the consistency, change in level, immediacy of effect, and overlap to evaluate the data between the baseline and intervention conditions. To analyze the change in level, we calculated the immediacy of effect. We used percentage of non-overlapping data (PND) to evaluate overlap and determined consistency by analyzing the level and trend similarities between similar conditions across the tiers (Barton, Lloyd, et al., 2018). To analyze the reliability and fidelity, point-by-point agreement was calculated for each (Barton, Meadan-Kaplanksy, et al., 2018; Ledford et al., 2018). Last, we explored the qualitative social validity interview by searching for possible themes within the caregiver's answers.

Results

We present the results by first speaking about the main dependent variable, caregiver implementation, and the results from the visual analysis calculations (see Figure 4). We then speak about the secondary variables under investigation, child outcomes.

Caregiver Implementation

For the mand instruction tier, results revealed a decelerating trend line and one session (#1, i.e., 20% of the data) fell outside of the stability envelope for the baseline condition. The relative level of change was 6.15. The mand intervention trend was relatively flat and all data points were within the stability envelopes. The relative level of change was 5.6. There was no change in the trend line direction between the baseline and intervention conditions. However, we calculated a large immediacy of effect (92.7%) and PND calculation (100%) between the mand baseline and intervention conditions.

The baseline data for the tact tier showed a flat trend line. Three of 10 (30%) of the data points fell outside of the stability envelope and the relative level of change was 3.7. We see an accelerating trend for the tact intervention data and one of 11 data points (9%) fall outside of the stability envelope, with a relative level of change of 14.11. We calculated differing trend directionalities for the tact tier (flat to accelerating), and a large immediacy of effect (81.5%) and PND calculation (100%).

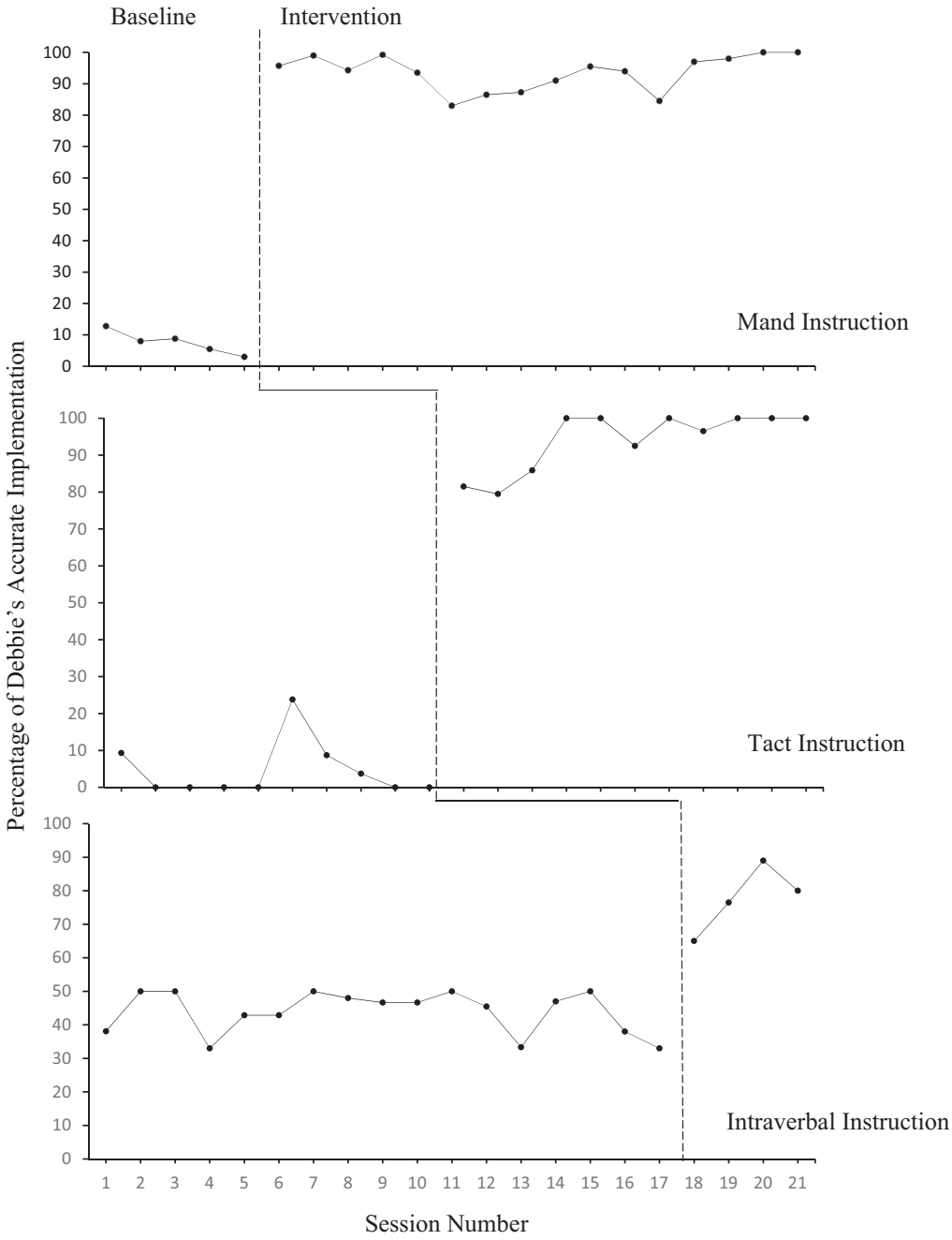

Figure 4. Caregiver Implementation Data.

The intraverbal baseline data was stable with three of 17 data points (17%) falling outside of the flat trend line. The relative level of change was 2.24. The intervention data was also stable; all four data points fall inside of the stability envelopes with a relative level of change of 13.95. The trend line for the intraverbal intervention was accelerating. Similar to the

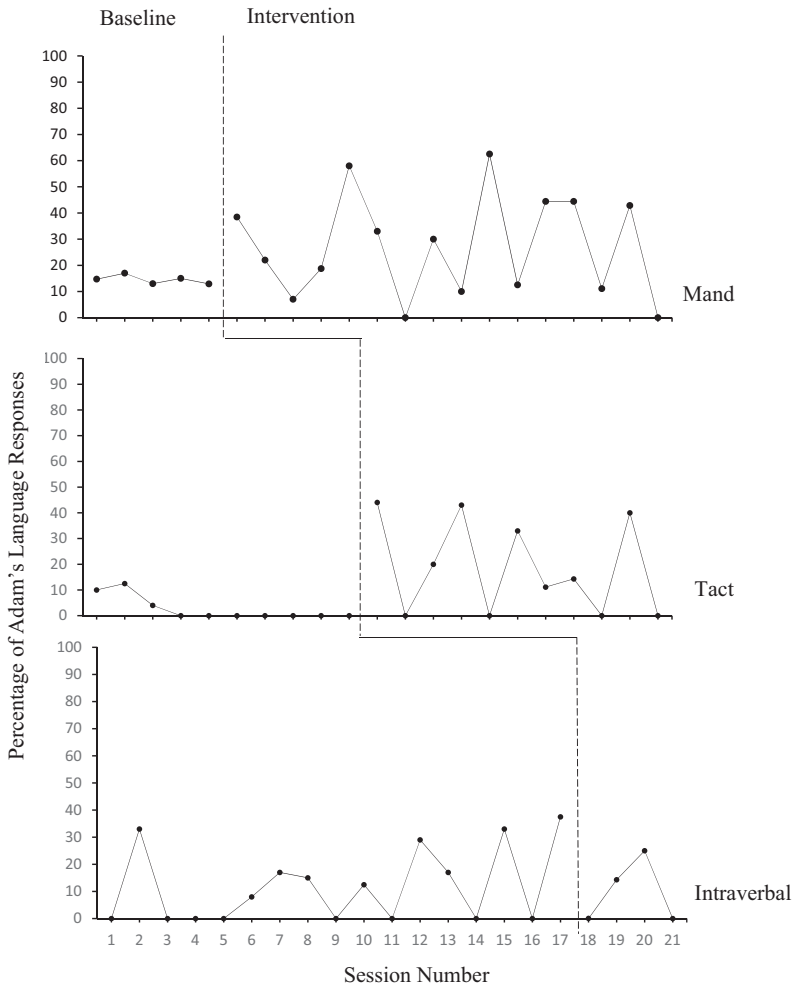

Figure 5. Child Outcomes by Operant Instruction.

tact tier, we calculated differing trend directionalities (flat to accelerating) and a large PND calculation (100%). However, we calculated a medium immediacy of effect (32%) between the intraverbal conditions.

Overall, after exploring the consistency of the data patterns across similar conditions we found the conditions have similar trends, stability, and PND calculations. Further, there is an immediacy of effect seen between each condition for each tier. When analyzing the consistency among the level calculations, similar baseline and intervention data patterns are seen for the mand and tact tiers, e.g., most baseline data are under 10% and intervention data averages are similar (mand average = 94.9%, tact average = 96.5%). However, the intraverbal level calculations are not consistent with the mand and tact data.

Child Outcomes

We visually inspected the data for the child outcomes (see Figure 5) and there are no clear trends, levels, and the data in the intervention conditions are not stable. Thus, we did not complete the visual analysis (Barton, Lloyd, et al., 2018). During the mand and tact baseline conditions, Adam was consistently not responding to Debbie's prompts for communication

and the level was stable around the calculated averages, 14.52 and 3.13 respectively. During these intervention tiers, the average for both the mand and tact tiers did increase to 27.18 and 15.8. During the intraverbal sessions, Adam often moved Debbie's arms to prompt her to do the motion during the "itsy bitsy" song. When this occurred, we coded this as Adam's attempt to communicate via sign language. Therefore, Adam's level of responding in the intraverbal tier was higher than the mand and tact tier and the average response rate between the baseline and intervention conditions did not vary considerably (from 9.54 in baseline to 14.09 in intervention).

Social Validity Results

During the social validity interview Debbie stated that at the end of the intervention and at the time of the interview (6 weeks after the last session), Adam had improved his communication. She stated, "If I was charting it and we were able to continue [the intervention], I think we were starting to see definite move upward." Debbie stated that Adam had improved in "so many ways" and he is saying the words more now, doing the sign, either prompted, or "saying the words out of the blue". Debbie went on to describe that she knew consistency was important, but now she understands the importance at a deeper level. She stated, "for him, sometimes, I have to really go the distance," meaning that it was important for her to be "constant and consistent even when I think it's never gonna happen." Debbie stated that throughout the intervention she sometimes got discouraged when Adam would not communicate. However, after constant repetition, Adam would start to communicate. "We must have done 'itsy bitsy spider' a million times and then it was like only the last sessions did he really start doing stuff and I just really thought he never would." Thus, by completing the intervention, Debbie described that it, "forced me to keep at something, whereas in the past, I was like 'mmm meh'" (meaning she didn't stick to a structured approach in the past). She emphasized that Adam "really does need that structured approach." When asked about the ease of implementation, Debbie explained that it was easy to implement and she taught others how to implement (e.g., Adam's great grandmother).

Discussion

Overall, the results show a functional relation between the intervention of BST and Debbie's ability to implement the parent-implemented DTT for the three verbal operants with accuracy. Immediately after Debbie was taught the parent-implemented DTT, she implemented all tiers with appropriate (> 75%) implementation accuracy. Further, she continued to implement the intervention appropriately and consistently, showing little variability in the data. Based on the trend direction for the intraverbal instruction, it appears she would have continued to use the intraverbal instruction with accuracy. We believe Debbie would have reached the criterion mastery during the next session if the study did not have to end prematurely because of the coronavirus (COVID-19) social distancing requirements put in place in March of 2020.

Since there were no clear data patterns and variability in the child outcome data, a functional relation was not established between the parent-implemented DTT intervention and Adam's communication. However, through the social validity interview, Debbie discussed she believed that Adam had increased his communication. Debbie explained that she has done many interventions in the past and "this is the first one that I'm steadily seeing improvement and it's not going away". Further, she discussed that the consistent, repetitive nature of the intervention (the DTT) was important for Adam, and it was easy for her and her family to implement inside and outside of the intervention sessions.

This study has important implications for research and practice. First, BST is typically used by applied behavioral analysts (Parson et al., 2012), and this study provides evidence that other professionals with little training can use BST to teach a caregiver how to implement a parent-implemented DTT for the VB operants with efficacy. Specific to caregiver implemented interventions, a meta-analysis by Nevill and colleagues (2016) found that there were many methodological limitations in the articles

describing the interventions. The researchers emphasize that the methods described in the research on caregiver implemented communication interventions must be improved. Following this recommendation from Nevill and colleagues (2016) and as recommended by Schaefer and Andzik (2020), we provided a detailed explanation of our BST procedures and caregiver implemented intervention that could make replication possible. Further, previous research has shown that when educators use VB, PII, and DTT coupled with the other EBPs incorporated in the study (i.e., prompting, modeling, and time delay), children increase outcomes related to language (DeSouza et al., 2017; Steinbrenner et al., 2020). This study is one of the first to show promising evidence that caregivers can implement a caregiver implemented DTT intervention for VB operants after minimal training and coaching from members outside of behavior analysis.

Limitations

As with most SCRD studies, the findings need to be considered with caution due to the low generalizability without replicated results (Gast & Ledford, 2018; What Works Clearinghouse, 2020). While we believe that our research makes an important contribution to the field, we must acknowledge the limitations of generalizability with the contribution of a $N = 1$ SCRD study. We also utilized a self-monitoring measure to support the coach's training fidelity. The self-monitoring measure was used when the coach implemented the caregiver training procedures. However, additional fidelity measures (e.g., having an independent observer take data to determine if the coach accurately implemented the training sessions) were not utilized. In the future, researchers need to ensure that additional fidelity measures are implemented to ensure the coach is implementing the training procedures with full fidelity.

By utilizing a parent-implemented DTT approach, the researchers were able to support caregivers in their home and provide advice on how to implement the DTT strategies in the natural environment; thus hoping to address some of the above-mention DTT limitations. We understand that the DTT approach has limitations; however, we were hopeful that the participants in the study would learn the DTT approach and then generalize the strategies learned into the natural environment; thus, increasing the child's ability to generalize skills learned. However, since the study had to end pre-maturely because of COVID-19 social distancing requirements, we were not able to collect the planned generalization and maintenance data. The social validly interview was, in part, collected 6 weeks after the intervention to understand if Debbie was continuing to use the intervention strategies (i.e., generalizing skills learned). However, we were also planning to assess for generalization and maintenance six weeks after the last session. During five follow-up sessions, we were going to prompt Debbie to simply play with Adam (similar to baseline procedures). In those sessions we had planned to take data to determine if Debbie was using the prompting procedures (maintenance) with differing items that Adam chose (generalization using different items), in a different setting (generalization outside of seated time at table).

During data analysis we did notice some limitations when we analyzed the data patterns. For example, during session 17, Debbie had a lower implementation score in the mand intervention tier that did not follow the data pattern. We are unsure of why this occurred; however, we hypothesize that it might have occurred because Debbie implemented the mand instruction over a longer period and intervention fatigue could have affected her score during session 17. During session 6, Debbie implemented some of tact procedures (e.g., received a 23.8% implementation score). This was the same day as the first mand intervention session; thus, she might have transferred some of the skills she learned from the mand conditions to the tact instruction. However, if this was the case, it was short-lived as the next four data points were below 10% (following the tact baseline data pattern). Last, the data were fairly consistent; however, the level of the intraverbal data was not. When completing the intraverbal tier in the baseline, Debbie would consistently sing and implement a time delay; however, she did not implement other steps of intervention to prompt communication. Thus, the level for the interverbal baseline condition (average = 45.30%) was higher

than the mand (average = 7.62%) and tact (average = 5.69%) baseline conditions because Debbie followed the first two steps of the intervention procedure before being taught. At the end of the study, the intraverbal intervention level was not consistent with the mand and tact conditions. However, after examining the trend line direction, we can see a largely accelerating trend for the intraverbal intervention. Thus, we hypothesize that if data collection had been able to continue, the data points would follow the same trend line pattern; thus, reaching a similar level to the mand and tact intervention conditions.

Adaptations

Throughout each session we learned more about Adam and Debbie and found it necessary to make adaptations starting as early as the baseline condition. Specifically, we changed the seating (from cube chair to highchair), decreased/changed the items used in the intervention, and asked Debbie to complete the intervention steps more quickly (i.e., providing a 2–3 sec TD as opposed to 3–5 sec). For example, right before the mand intervention (session 6), Adam suffered a concussion and his doctor recommended limiting the use of screen time. Thus, the iPad was not used for the intervention. Debbie suggested using one of his current favorite foods, an apple, for the intervention instead. Since the apple was not tested during the preference assessment, we are not certain that this was a highly motivating item for Adam. The materials changed again during session 11, right before beginning the tact tier. During baseline, the coach and Debbie noticed that Adam got upset when shown the picture of "outside" that was originally used for the tact tier. Adam loves to go outside; thus, Debbie and the coach thought Adam might be associating the outside picture with a request to go outside instead of a request to tact. Thus, for the tact tier, we used a shoe and baby instead.

Throughout the study, Adam also displayed challenging behaviors to attempt to leave the intervention session. If provided a break, he did not want to transfer back into the session. It is hard to tell why Adam did not appear to enjoy the intervention sessions as behaviors did seem sporadic; however, Adam did scream and attempt to leave the session more often after a prolonged break from illness. Thus, consistency seemed very important to Adam. For example, the coach did not visit with the family during the university December holiday break. The break didn't affect Debbie's implementation and Adam did respond to the intervention and was content at first after the break; however, during sessions 15 and 16, Adam began to attempt to elope more. After consultation with the first author, Debbie began to attempt to make the sessions more fun by providing more rewards, e.g., chips were provided more often.

Overall, when the intervention sessions were consistently implemented, utilizing familiar environmental supports (e.g., high chair that was used at meal times), and when Debbie implemented the intervention fast, rotating through the items in a random order, providing rewards (chips) after each trial (other than mand trials), Adam displayed less challenging behaviors and attempted to communicate more. For example, these teaching strategies were used in session 20 and Adam used words and sign language to mand, tact, and use intraverbals at one of the highest rates seen throughout the intervention (42.85%, 40%, and 45% respectively). Despite the need to introduce the above adaptations for Adam, the use of BST resulted in consistent improvement for Debbie related to her implementation of a parent-implemented DTT.

Implications for Future Research and Practice

Child Outcomes. While the dependent variable under investigation was Debbie's ability to implement the intervention as prescribed, we also took data on Adam's responses (i.e., his ability to use words or sign language to mand, tact, or use an intraverbal). His progress was inconsistent, and the data varied. Thus, we cannot make a claim that the intervention increased his ability to communicate. As noted in the background interview, Debbie emphasized what we noticed through observing Adam throughout the study: it was hard to motivate Adam to communicate because of his perceived lack of motivation to receive the items present in the intervention. Debbie

stated that she never understands what his favorite items are because they change quite often. Further, when Adam is not immediately reinforced, he often walks away from his communicative partner. This perceived lack of motivation also may be related to what Debbie stated in the social validity interview: Adam "figured out the pattern", and instead of communicating, would simply wait for Debbie to physically prompt him because he knew he would get the item regardless. Prior to intervention, Debbie provided Adam with items after he demonstrated no or very little effort to communicate. Thus, Adam has potentially learned he doesn't need to communicate to receive desired items.

Coaching Recommendations. By writing anecdotal notes after each session, we recorded competence information to explore how effectively Debbie implemented the intervention and responded to Adam's behavioral cues. When reflecting more on Adam's challenging behaviors, we found it necessary to analyze these anecdotal notes more closely to understand if we could determine how Debbie was responding to Adam's behavioral cues, and if Debbie or the coach could have intervened more to support Adam. It is true that the coach did not need to intervene often to help Debbie respond to Adam's behavioral cues, Debbie was able to respond quickly after Adam became disengaged. However, when we analyze Adam's communication specific to the operants, it is clear Adam did not consistently benefit from the intervention.

Consistent with previous literature, we found that BST can be effective for teaching a caregiver to implement DTT (Leaf et al. 2019; Schaefer & Andzik, 2020). Further, while DTT can be effective for increasing commutation skills for children with ASD (Coleman et al., 2020; NAC, 2015; Steinbrenner et al., 2020), we did not see improved communication skills for Adam. Unfortunately, the literature often reports lack of increased child outcomes when researchers are studying caregiver's implementation fidelity. For example, in a meta-analysis studying parent-implemented interventions, Nevill and colleagues (2016) found there were many methodological limitations in the parent-implemented intervention literature. Many of the reviewed articles provided an incomplete description of the interventions and minimal improvements in child communication outcomes. Researchers do not seem to have a full understanding of why child outcomes may not improve when using a parent-implemented interventions; however, a possible reason is the intervention may not be suitable to the child's behavioral characteristics. For example, in our study, Adam might not have benefitted because there were many sessions where his challenging behaviors disrupted the learning opportunities (e.g., session 8: Adam consistently attempted elopement; session 9: was hyper-focused on the cars he was attempting to play with; session 12: ended early because prior to session Adam had a "tantrum" and was in a bad mood).When Debbie sought advice on how to respond to Adam's behavior, the coach provided feedback before and after the session. Because Debbie received feedback after the session occurred, the coach might have missed opportunities to help Debbie better respond to Adam in the moment. If the coach was utilizing bug-in-ear technology to provide support (e.g., asking Debbie to wear a blue tooth earpiece), the coach could have provided feedback and support in the moment. In-the-moment feedback would have allowed Debbie to make immediate adaptations to respond to Adam's behavior and these adaptations could have supported Adam's communication. Bug-in-ear coaching has been successfully used in early childhood to provide support to teachers (Coogle et al., 2021); however, it has not yet been extensively utilized in the home environment with caregivers. Future research should consider such technology not only because of the immediate feedback, but because of increased access for families who may not live in areas with access to these professionals.

Conclusion

Young children with ASD frequently require supportive interventions that address communication delays. Because children spend time with their caregivers and the home is typically their natural environment, it is critical caregivers are trained to implement effective communication interventions in the home setting.

PII is an evidence-based practice that has been shown effective for young children, birth to 5 years, with ASD in the area of communication (NAC, 2015; Steinbrenner et al., 2020). However, effective models of training are required. BST is a model of training that, as demonstrated in our study, is an effective model to train caregivers. BST is not only effective but is relatively easy to implement and lends itself to a collaborative experience between the professional and caregiver. Training therapists, early interventionists, and educators to use BST for PII for caregivers of children with ASD can lead to more effective training. The protocols developed during this study can be used in multiple disciplines and can provide a model for interdisciplinary professionals working with families and children with ASD. When all professionals are utilizing the same intervention and providing families similar recommendations, children are more likely to receive consistent intervention implementation from their various therapists, including caregivers, leading to better outcomes for children.

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