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Teaching Peer Imitation to Preschool-Aged Children with Autism Spectrum Disorder Using a Video Modeling Treatment Package

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TEACHING PEER IMITATION TO PRESCHOOL-AGED CHILDREN WITH AUTISM USING A VIDEO MODELING TREATMENT PACKAGE

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ABSTRACT

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Peer imitation is a skill that serves to promote the acquisition of new play skills, problem-solving skills, and academic skills through observation of one's peers. Although peer imitation is an important pre-requisite for learning from peers, many autistic children experience deficits in this area. In the present study, we evaluated a video model treatment package to teach autistic children to imitate their peers. Additionally, we conducted free play probes pre- and post-training to assess the transfer of training to a natural play setting. The results of the current study are mixed. One participant's imitation skills generalized to the in-vivo sessions and to untrained targets after training with only one set of video models. Two participants mastered imitation of one set of video models; however, their skills did not generalize across sets nor to in-vivo conditions. Data from free play probes show that one participant attended to his peer more, but there were only slight changes in imitation across participants following video model training. Hypotheses for these results and ideas for future research are discussed.

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LIST OF ABBREVIATIONS

ASD	Autism Spectrum Disorder
BL	Baseline
DOR	Differential Observing Response
DSR+	Differential Reinforcement
DTI	Discrete Trial Instruction
EC	Error Correction
IOA	Interobserver Agreement
M	Mean
MSWO	Multiple Stimulus Without Replacement
NDR	Nondifferential Reinforcement
SR+	Reinforcer
VM	Video Model

CHAPTER 1: INTRODUCTION

Generalized imitation is a behavioral cusp that allows a learner to acquire new skills from a variety of models without explicit training that exposes the individual to new contingencies, environments, and reinforcers (Rosales-Ruiz and Baer, 1997). Unfortunately, imitation is a deficit for many individuals with autism spectrum disorder (ASD; Rogers et al., 2003). For this reason, imitation is one of the first operants that practitioners target in early intervention. Once children can reliably imitate a model, model prompts can be incorporated into training new skills such as receptive instructions and activities of daily living; furthermore, an imitative repertoire is related to improved language acquisition, play skills, and joint attention (Ledford & Wolery, 2011; Rogers et al., 2003).

Research had shown that both adult and peer models are effective in promoting maintenance and generalization of imitation, however, peer imitation is especially important for children to acquire age-appropriate behaviors in the natural environment without adult mediation (Soorya et al., 2003). Children with ASD may require specific training to attend to peers and to imitate peer models because they have difficulty generalizing from adult to peer models (Apolloni et al., 1977) and they have deficits in social skills that hinder general interaction with peers (Soorya et al., 2003). Both are barriers for establishing peers as valuable models.

Research studies on peer imitation training for children with ASD and developmental disabilities (DD) have used a variety of methods such as follow-the-leader (e.g., Carr and Darcy, 1990), video modeling (e.g., Sansing, 2017), reciprocal imitation training (e.g., Walton and Ingersoll, 2012), and small group instruction with a progressive time delay (e.g., Ganz et al., 2008; Garfinkle and Schwartz, 2002; Sweeney et al., 2018). For example, Carr and Darcy (1990) evaluated the generalization effects of teaching children with ASD to imitate the actions of a typically developing peer. The peer and the child approached an object, and the peer instructed the child to “watch me.” The typically developing peer administered a prompting procedure if the child emitted an incorrect response. After teaching on multiple exemplars, the researchers tested for generalization on a novel set of objects. All four children correctly responded to the generalization probes on more than 90% of opportunities across multiple sessions. The results of this study showed that multiple exemplar training is important for generalization of peer imitation skills. One limitation of this study is that it can be difficult to use a typically developing peer to teach imitation skills when working in an early intervention clinic where typically developing peers are typically not present. Thus, researching methods for teaching imitation without a highly trained, typically developing peer is beneficial for practitioners to be able to target this skill in clinical settings.

Sweeney et al. (2018) conducted 10-min sessions with 2-4 year-old children in which they provided a prompt to the child to imitate their peer once every minute during a structured sculpting play activity. Initially, the therapist immediately provided a physical prompt to imitate the model (i.e., a 0-s prompt delay). After three sessions using a 0-s prompt delay, the therapist used a 6-s prompt delay in which the therapist provided a physical prompt only if the target child did not imitate their peer within 6 s. The experimenters collected data on prompted and unprompted imitation, both of which were reinforced during intervention phases. If the child imitated their peer for at least 1 s and within 6 s of the model, it was considered unprompted peer imitation. Because three of the four peers did not initially provide salient models, the experimenters provided them with visual prompts that depicted specific actions to perform. Additionally, the two children with ASD required differential reinforcement modifications for prompted responses to reduce prompt dependency.

A limitation of Sweeney et al. (2018) is that the experimenters did not test for generalization of peer imitation to activities other than sculpture play. While all participants engaged in more unprompted peer imitation than prompted peer imitation by the end of the study, the naturalistic setting lends itself to less control over the variety of the actions modeled by the peer as well as the complexity of the actions. Teaching using a discrete trial instruction (DTI) format would allow the therapists to control the saliency and complexity of the model. DTI also permits the therapist to use error-correction procedures. Error-correction procedures often include remedial trials that require the re-presentation of the discriminative stimulus, which in this case, is the model (Carroll et al., 2015). In a natural play setting where peer models are uncontrolled, it is not possible to re-present the model for an error correction trial without disrupting the peer's natural play.

Video modeling is an empirically based teaching method that has been used to teach a wide variety of skills to individuals with ASD (MacDonald et al., 2015). This technique typically involves presenting a video model of target behaviors and testing the individual's demonstration of the skill in the natural environment. Video models have been used to teach self-help (e.g., Charlop-Christy et al., 2000), social skills (e.g., Nikopoulos and Keenan, 2004), play skills (Reagon et al., 2006), and observational learning (e.g., Sansing, 2017). Researchers hypothesize that video models are effective because individuals with ASD prefer to view videos, thus they are motivated to attend to the model (Bellini and Akullian, 2007). Additionally, video models depict the relevant components of the target performance to combat tendencies of individuals with ASD to attend to irrelevant components of the environment (i.e., over selectivity; Ploog, 2010). Video models are also a feasible method for teaching skills, such as peer imitation, in a DTI format because the peer does not have to spend time away from their treatment to participate, and the video models can be replayed immediately when implementing error correction. Additionally, the same video models can benefit multiple children, and research has shown that they promote faster acquisition (Charlop-Christy et al., 2000).

One important characteristic of behavior change is its generalizability. Research studies that compared the effects of video models and in-vivo models have shown that video models are equally or more effective when teaching skills and demonstrating generalization of the skills to the natural environment (Charlop-Christy et al., 2000; Odluyurt, 2013). Sansing (2017) found that participants demonstrated generalization of the skills learned via peer video model to the in-vivo scenarios and to task variations (i.e. stimulus generalization); however, the participants' observational learning skills did not generalize across tasks. Sansing summarized, in congruence with Carr and Darcy (1990), that multiple exemplar training of a sufficient variety of video models could promote generalization to novel behaviors. Thus, the current study used multiple exemplars of video models to assess the generalizability of peer imitation learned through a video modeling treatment package.

The present study used techniques outlined by previous imitation studies, such as using prompt delays and contingent reinforcement, but with some added components. This study involved the use of discrete trials of video model presentations of peers to promote effective control of imitative opportunities, to capitalize on the effects of error correction, and to precisely measure imitative responses. We also included children with ASD as the peer models in pre- and post-training probes to assess generalization of the skill from video models to the natural environment. Finally, we assessed the generalizability of skills from a DTI setting to a natural environment play setting. The purpose of the current study was (a) to establish procedures that teach children with ASD peer imitation, and (b) to test the transfer of these skills to the natural environment and across target behaviors.

Chapter 2: METHOD

Participants and Setting

Three target children and three peer models with ASD participated in the current study. Each participant received applied behavior analysis services from a community-based early-intervention clinic at the time of the study. Target children could imitate motor actions performed by an adult, sit at a table, and attend to a video for 10 s. Peer models participated during pre-training sessions, post-training sessions, and free-play generalization probes. Peers participated if they could perform a target action on cue (e.g., using a video model or cue cards), and if they could independently play with toys for 5 min. Peers were matched with the target child according to availability. A summary of characteristics for each target child and peer are outlined in Table 1.

The experimenter conducted sessions at a table in a small room located within an early intervention clinic.

Materials

The materials present for each session were a child-sized table, child-sized chairs, data sheets, target stimuli, preferred stimuli, timers, token boards, video models, and a video camera. An additional therapist was present during sessions in which the peer was present. Participants were required to wear a mask when the peer was present except for Participant 1 because his peer was his sister[1].

Video Models

The experimenter used video models that depicted a peer engaging in the motor actions outlined in Table 2. Video model creation followed guidelines outlined by Nikopulous and Keenan (2006). Each video depicted one model who performed all of the actions in the same setting in which the target children learned. These videos were brief (i.e., a maximum of 7 s), and they showed a close-up of the action performed. The peer sat at a table with the target object in front of them with about 3 in. of space in front of the object. The experimenter edited the videos to remove extraneous activity and sound to ensure that the visual components of the peer model would be more likely to control the viewer's behavior. The videos also started and ended with a black screen.

Initially, the video models were a recording of one peer model that would be used for all participants. This model was Andrew, who was also Brenna's in-vivo peer. After teaching set 1 targets to Gabe using the video model of Andrew, the experimenters switched to using a video model of Gabe's peer, Suzy, for teaching set 2 and set 3.

[1] A portion of this study was conducted during the COVID-19 pandemic.

Identification of Target Responses

The experimenter created three sets of targets. Each set of targets consisted of a set of Fisher Price® toys and three target actions using those toys. For example, set 1 was an airplane set with a pilot, a box, and an airplane (for additional descriptions see Table 2). The objects were arranged in a line and in the same location for each trial, and each target was presented three times per session for a total of nine trials.

Measurement

Dependent Measures and Data Collection

The primary target response was independent imitation of a motor action with objects. The experimenter recorded imitative responses as independent correct, prompted correct, error, or as a non-response. An independent correct response was defined as the child independently imitating the model within 5 s of the instruction, and without touching a non-target object within 2 s of imitating the correct response. A prompted response was defined as a correct response performed with the help of a gestural, partial-physical, or physical prompt to imitate the model. Errors were scored when the child emitted a response other than the one modeled, and a non-response was defined as the child not making any motor movements toward the target objects within 5 s of the instruction. Additionally, the experimenter collected data on attending and challenging behavior. Experimenters recorded attending as (a) independent attending, defined as the child orienting their head and gaze toward the model before the instruction “look” without shifting their gaze for more than two consecutive seconds; (b) prompted attending, defined as the child orienting their head and gaze toward the model within 2 s of the instruction “look.” Challenging behavior was recorded per trial when negative vocalizations, aggression, property destruction, or flopping occurred. Operational definitions of challenging behaviors are available by the first author upon request. These measures were the same for training, and pre- and post-training sessions. The experimenter converted each dependent measure to a percentage of trials by dividing the number of trials with an occurrence of a participant response by the total number of trials in a session and multiplying by 100.

During free-play probes, the experimenter collected frequency data on (a) spontaneous attending, defined as the child orienting their head and gaze toward the peer for at least 3 s without shifting their gaze for more than 1 s; (b) spontaneous, immediate imitation, defined as copying a discrete play action of a peer within 5 s of the peer's model and without prompts by the therapist to imitate the model; and (c) independent, immediate imitation, defined as copying a discrete play action of a peer within 5 s of the peer's model after a the therapist vocally prompted the child to imitate the model (i.e., imitating the peer after the therapist instructed the child to "do what they did"). The experimenter also collected data on discrete play actions of the peer model defined as a motor action with at least one of the toys in the array that is visible to the child. The experimenter used these data to determine the proportion of peer actions that the child spontaneously imitated by dividing the frequency of spontaneous imitation by the frequency of discrete play actions modeled by the peer.

Interobserver Agreement and Treatment Integrity

A secondary observer recorded data on imitation, attending, and challenging behavior for an average of 48% (range = 30% - 79%) of baseline, in-vivo, and video model sessions. If the experimenter and the secondary observer scored all behaviors of single trial the same, they scored the trial as an agreement. If the experimenter and the secondary observer scored one or more behaviors of a single trial differently, they scored the trial as a disagreement. Trial-by-trial interobserver agreement (IOA) was calculated by dividing the number of trials with agreement by the total number of trials and multiplying by 100 to obtain a percentage of agreement for the session. The mean IOA was 95% (range = 77%-100%) for Miles, 90% (range = 77%-100%) for Gabe, and 98% (range = 88%-100%) for Brenna.

Additional observers also recorded treatment integrity (TI) for the same sessions used to collect IOA. They calculated data on the correct implementation of training components performed in a given session such as setting up the trial, securing attending, and providing the specified response interval (for a full list and description of each component, see Appendix A). The observer either recorded each component as performed correctly or incorrectly for each trial. The entire trial was scored as incorrect if they scored an error for any components in the trial. A TI percentage was calculated for DTI sessions by dividing the number of correct trials by the total number of trials and multiplying by 100. Mean TI was 97% (range = 66%-100%) for Miles, 96% (range = 88%-100%) for Gabe, and 91% (range = 77%-100%) for Brenna.

Assessments and Pre-training

Preference Assessments

Prior to pre-training probes, the experimenter conducted a multiple stimulus without replacement preference assessment for the target child and the peer (MSWO; DeLeon and Iwata, 1996). The MSWO involved eight sessions in which the experimenter presented an array of eight different tangible items. After eight sessions were completed, the experimenter calculated the percentage of selection for an item by taking the number of times the item was selected and dividing it by the number of times the item was presented and multiplying by 100. The top five items with the highest percentage of selection continued as options for the participants to choose as preferred items during research sessions. After the participants acquired all of their tokens, the therapist provided access to the top preferred item. Additionally, if clients requested something other than the items from the preference assessment, the experimenter honored their request.

Assessment and Pre-training for Target Child

Generalized Imitation. To ensure that the target child had a generalized, one-step imitative repertoire, the experimenter conducted a one-step imitation probe. The experimenter and the child each had a matching set of three objects arranged in a line in front of each of them. For each trial, the experimenter performed an action with one of the objects, and then instructed the child to "do what I did." The experimenter blocked the child's hands if the child attempted to respond prior to the completion of the model. If the child engaged in a correct response, the experimenter provided praise and a token. If the child engaged in an error or no response, the trial ended. The targets are outlined in Table 2. The experimenter ran a minimum of two, six-trial sessions and a maximum of six sessions. If the child performed at 83% across two consecutive sessions, they were included in the study. If the child did not initially meet criteria, the experimenter re-tested this skill after additional training.

Attending Prompt Assessment. The experimenters developed this assessment to determine the type of prompt to use to ensure attending toward the model. The child sat across from a peer at a table, and the peer engaged in an activity (e.g., looking at a book or playing with playdoh). The experimenter provided the instruction "look" and one of four specified prompts to the child (see Table 3). They presented each prompt for five consecutive trials and from least-to-most intrusive. If the child responded to 80% of prompts at a given level, the therapist tested the next intrusive prompt and then ended the assessment so that the child did not endure unnecessary, intrusive prompts. A correct response was recorded and the child received praise and a token if they attended to the peer for any amount of time within 2 s of the presentation of the instruction. If the child did not attend to the peer after 2 s, the trial ended. The experimenter interspersed mastered tasks following on average every two trials that the target child did not earn a token. The peer earned a token and praise each time that the target child received one as long as the peer was engaging with the activity. The least-intrusive prompt that guided the child to respond correctly for 80% of trials at that given prompt level was the prompt that the experimenter used for all procedures henceforth.

Assessment and Pre-training for Peer Model

Video-model Imitation. The experimenter tested the peer's immediate, two-step imitation skills using a video model of a peer depicted on an iPad®. The peer sat across from the experimenter and had three objects arranged in line in front of them. For each trial, the experimenter queued the video model and told the peer to "look" while prompting them to look at the screen before pressing play. After the video ended, the experimenter removed the iPad® and told the peer to "do what they did." If the peer correctly imitated the sequence, they earned praise and a token. If the peer engaged in an error or no response, the trial ended. The experimenter ran a minimum of two, six-trial sessions and a maximum of six sessions. If the peer imitated the videos with 83% accuracy across two consecutive sessions, they were in included in the study.

Responding to Picture Cue. Technical difficulties sometimes caused delays during in-vivo sessions. For example, sometimes the video took a long time to load at the start of a trial. For this reason, Suzy learned to perform a correct model given a picture cue rather than using a video model. After teaching using a 5-s prompt delay, the experimenter tested this skill using the same inclusion criteria as the video-model imitation probes.

Experimental Design and Procedures

The experimenter used a nonconcurrent multiple-baseline across participants design with embedded multiple probes to evaluate the effects of a video-modeling treatment package on peer imitation. Additionally, multiple probes were conducted pre- and post-training to assess the maintenance and generalization of peer imitation skills to additional sets of targets. The experimenter also tested for generalization to the natural environment by conducting free-play probes before and after video model training of each set of targets. ~~Figure 1 depicts the training and probe sequence for training~~. The experimenter conducted one to two training sessions per day, three to five times per week. Sessions were each nine trials and lasted about 15 min.

Baseline Sessions

The target child and peer model sat next to each other at a table. The peer's therapist placed the objects on top of a large lid on the table in front of the peer. The peer's therapist showed the peer a video model, or a picture cue, of the target model to perform. The experimenter prompted the target child to "look" at the peer model. When the peer completed the model, their therapist slid the objects in front of the target child. The experimenter then instructed the target child to "do what they did." Baseline sessions did not include programmed reinforcement for correct target responses. The peer model earned a token for correctly imitating the video model.

Mastered targets were interspersed approximately every two trials to provide an opportunity for the target child to earn tokens and promote engagement during sessions. If the target child responded below mastery criteria of 88% correct responding across three consecutive sessions and without an increasing trend, they continued to video model training for set 1.

Video-Model Training

Sessions were set-up the same as baseline sessions, however the peer was not present. Training of each set of targets began with a 0-s prompt delay in which the experimenter presented the video model, then immediately physically guided the child to imitate their model after presenting the instruction "do what they did." Following a prompted response, the experimenter provided praise and access to a preferred tangible item for 30 s. After three sessions, the prompt delay increased to 5 s in which the child had 5 s to engage in an independent correct response. Following an error, the experimenter blocked further responding, re-presented the model and instruction, then physically guided the correct response. If the child's data did not depict an increasing trend after three consecutive sessions, the experimenters added error correction to training sessions. In these sessions, the experimenter then restarted the trial after an error to provide another opportunity for the child to perform an independent, correct response. The experimenter continued this sequence up to three times or until the child performed an independent, correct response. The experimenter provided praise and access to a tangible item for any independent, correct responses that occurred during the trial (including during error correction). After the target child correctly responded to the initial model greater than 50% of trials for two consecutive sessions, the experimenter only provided praise for correct responses that occurred during error correction (i.e., differential reinforcement). Training continued until the child's independent, correct responses were greater than or equal to 88% across three consecutive sessions. There was also a discontinuation criterion of six to nine sessions of variable responding at the same level or without an increasing trend. When the child met mastery or met the discontinuation criteria, in-vivo probes were conducted with the peer.

Individualized Procedural Modifications

After participants did not engage in the intended pattern of responding, the experimenters made procedural modifications. This occurred after a decreasing trend in responding or when the trend of attending or imitation responses did not match that of a previous training condition (e.g., responding to set 2 video models did not match that of set 1).

Miles's Modifications. The first participant started showing signs of prompt dependence such as reaching for the experimenter's hands to prompt. To reduce this dependency, the experimenter changed the structure of each trial so that the child had two opportunities to respond independently before least-to-most prompts were used. That is, after the first error, the experimenter said "let's try again" and re-presented the video model without prompting a correct response. If the child responded independently to the second presentation, the trial ended, and they received praise, access to a tangible, and an edible. If the child did not respond correctly to the second presentation, the experimenter said "let's try again, I'll help you," and re-presented the video model a third time. Upon completion of that model, the therapist used least-to-most prompts to guide the correct response and provided praise and access to a tangible only (i.e., differential reinforcement). Miles started this error correction at session 12, and Brenna started at session 21. Gabe used this error correction from the start of his training with tangibles only.

Miles used tokens prior to session 12 when experimenters switched to using tangible and edible reinforcers. For the last four sessions of the video modeling condition, the experimenter used behavioral momentum if he was not attending by presenting one to two mastered tasks before the presentation of the video model to increase attending to the video model.

Gabe's Modifications. At session 24, the experimenter implemented a behavior momentum procedure as described above to increase Gabe's attending to the video model. Gabe continued to show signs of prompt dependency during set 2 training, thus at session 28 the experimenter changed the error correction again. The new trials were the same as the original error correction procedure except the video model was only presented one additional time (i.e., one error correction). These sessions did not use differential reinforcement. Minimal behavior change occurred after this procedural change, and he would routinely touch the marshmallow toy for each trial, thus set 2 training was discontinued for Gabe.

Brenna's Modifications. At session 18, Brenna switched from a token schedule to continuous reinforcement of edibles and tangibles. For all subsequent video modeling sessions, the experimenter used the same differential reinforcement arrangement as described for Miles.

After Brenna mastered set 1 with the video model but the skill did not transfer to the in-vivo set-up, the experimenter began teaching set 1 targets in-vivo for two sessions. Because this was time-consuming for the peer and Brenna engaged in many "no responses", the experimenter discontinued this training after 5 sessions, and moved to teach set 2 using the video model.

Free-play Generalization Probes

The experimenter tested for transfer of training to a free play context. During these 5-min sessions, each child had the same Fisher-Price Little People ® baby playset consisting of 15 pieces each. The children sat next to each other at a table. At the start of the session, they were told to "play." After every 1 min that elapsed, the experimenter pointed toward the peer model and instructed the target child to "do what they did." They would delay the instruction up to 10 s if the peer model was not engaging in a discrete play action. If the peer model did not engage in a discrete play action within 10 s of the delay, the experimenter skipped that trial. The child could engage in a maximum of five independent imitations; however, the number of discrete actions modeled by the peer limited the number of spontaneous imitations the child could imitate. The experimenter provided tokens to the children for "good playing" about once per minute to promote continued engagement. At the end of the session, the children could exchange their tokens for a preferred tangible item.

Brenna was paired with a novel peer for an additional free play probe following mastery of video model training for set 1. She was paired with Molly because Andrew had to be prompted multiple times to play with the toys.

Maintenance

In-vivo maintenance sessions were conducted once a week for two weeks post-mastery using the same procedure as in baseline.

Chapter 3: RESULTS

The results for Miles are depicted in the top panel of Figure 1. In baseline, Miles performed with less than 50% accuracy across all three sets of targets. For set 2 and set 3, he imitated one target from each set correctly for all three trials that it was presented resulting in 33% accuracy for those sessions. After three sessions of a 0-s PD condition (not graphed), Miles imitated set 1 targets from a video model with 44% accuracy. However, he began engaging behavior that indicated prompt dependency, thus an error correction change was implemented. Immediately after implementing this change, his behavior increased to 77% correct responding. In the 20 sessions that followed, Miles's accuracy was variable (*M* = 68%; range = 44%-88%) at which point he met the discontinuation criteria for the video model intervention for set 1. Post-video model training on set 1, Miles correctly imitated his peer with 77% accuracy across all 3 sets of stimuli. Because this level of performance was near the mastery criteria, the experimenters did not think it was necessary to intervene using the video models to train the additional sets and considered his performance socially significant by his treatment team. At one- and two-weeks post-mastery, his behavior maintained near his level of performance in weeks prior (*M* = 66%, range = 55%-77%).

Miles's independent attending behavior is graphed in the top panel of Figure 2. Prior to video model training, attending to his peer was at or below 55%. During video modeling training, his independent attending increased to an average of 79% (range = 33%-100%). Attending during these sessions appears to correlate with his imitation performance. For example, he independently imitated 11% of the time and independently attended 33% at session 11, but at session 12 he independently imitated 77% of the time and independently attended 88% of the time. Attending to the in-vivo peer increased for sets 2 and 3 (66% and 77%, respectively), but less so for set 1

(44%). During maintenance his attending for sets 1 and 3 decreased to 33% while set 2 attending maintained at 66%. His independent attending to the in-vivo peer does not appear to correlate with independent imitation in the same way it did during video model training.

The top panel of Figure 3 depicts Miles's performance on the naturalistic play probe pre- and post-video-model training. Before training, Miles engaged in zero instances of independent and spontaneous imitation, and he attended to his peer twice. After video model training, Miles's independent imitation increased to two occurrences, and he spontaneously imitated twice. Notably, his attending increased to nine occurrences.

The results for Gabe are depicted in the second tier of Figure 1. During baseline sessions, Gabe performed at or below 11% for set 1, and at or below 22% for set 2 and set 3. After 0-s PD sessions, Gabe met mastery of set 1 targets after four sessions. However, upon the return to in-vivo sessions with set 1 targets, his performance decreased to a mean performance of 19% (range = 0 % - 44%). During set 2 video-model training, Gabe engaged in variable, low levels of correct imitation (*M* = 24%; range = 0% - 44%). Despite making a change to his error correction procedure at session 28, there was minimal level change to his performance on set 2 targets. Initially, Gabe's performance increased after 0-s PD sessions for set 2, but then it decreased to 0% and remained variable with an average of 27%. At this point, training met discontinuation criterion for set 2. His set 3 in-vivo performance remained at low to zero percent correct responding. His performance on set 3 targets during video model training initially increased to 55%, however, his responding then decreased and remained variable with an average of 27%. Gabe met discontinuation criterion for set 3 video model sessions as well, and his clinical team agreed that his progress was not socially significant enough to continue training.

Figure 2, panel 2 depicts Gabe's independent attending. Initially, Gabe's attending to his peer increased during baseline sessions from 22% to 77% for set 1. Attending for set 2 matched his independent imitation performance at 22%. However, attending to set 3 models occurred during 55% of trials while his imitation of set 3 targets remained at zero. During video model training, Gabe's attending increased to an average of 95% (range = 77%-100%). Post-mastery of set 1 targets with the video model, Gabe's attending maintained for set 1 (*M* = 79%, range = 77%-88%); however his responding in set 2 sessions increased above pre-training levels (*M* = 59%, range = 33%-88%). Although attending during in-vivo sessions does not appear to correlate to imitation performance, his attending to the set 2 video models occurred at the same level as imitation. His average independent attending during this condition was 28% (range = 11%-44%) and his average independent imitation was 24% (range = 0%-44%). During in-vivo baseline sessions for set 3, there appears to be an inverse correlation between attending and imitation where attending is high (*M* = 72%, range = 11%-100%) but imitation is low. Finally, during set 3 video model training, his attending performance (*M* = 26%, range = 0%-55%) occurred at the same level as his imitation performance (*M* = 27%, range = 0%-55%).

Gabe's free play probe data are depicted in the second tier of Figure 3. Pre-video-model training, he engaged in zero occurrences of independent or spontaneous imitation, and he attended to his peer six times. Post-mastery of set 1, Gabe imitated his peer independently one time, spontaneously imitated his peer zero times, and attended to his peer four times.

Brenna's results are depicted in the third tier of Figure 1. Prior to any video model training, Brenna performed at or below 33% for set 1, at 11% for set 2, and at 44% for set 3. After 0-s PD sessions, she met mastery criteria for set 1 targets after 16 sessions. Although her behavior did not immediately change after the 0-s PD sessions, once the error correction procedure changed at session 21, there was an immediate level change in performance that continued increasing until mastery. However, upon returning to in-vivo sessions with the peer, her performance maintained near baseline levels for set 1, while performance with set 2 and set 3 targets increased slightly (*M* = 31%, range = 22% - 33% for set 2). During video model training for set 2, Brenna's accuracy was variable, and the level only increased slightly (*M* = 36%; range = 22% - 55%). After session 47, Brenna was discontinued from the study because she was overly attentive to one stimulus (the marshmallow), and she met the pre-determined discontinuation criterion.

Brenna's independent attending data are graphed on the third panel of Figure 2. In baseline, Brenna attended to her peer 11% of the time or less for 8 out of 9 sessions (*M* = 10%, range = 0%-66%). During video model training for set 1, Brenna attended to the video model on average 88% of trials (range = 66%-100%). These data do not correlate with her independent imitation responses performance in this condition. In the next in-vivo phase, Brenna's attending to her peer increased from baseline levels, but it was lower than attending in the video model phase (*M* = 45%, range = 22%-66%). Finally, she attended to the set 2 video models for an average of 88% of trials for the first five sessions (range = 47%-100%); however, attending decreased over time to an average of 57% of trials (range = 33%-77%).

The third panel of Figure 3 depicts Brenna's play probe data. Before she participated in video model training, she engaged in two instances of spontaneous peer imitation, two instances of independent imitation, and four instances of attending. After training on set 1, Brenna's attending maintained when paired with her original peer and increased to six instances when paired with Molly. Independent and spontaneous imitation decreased to zero instances for both sessions with Andrew and Molly.

CHAPTER 4: DISCUSSION

For one participant, Miles, this video-model treatment package was a successful intervention to increase peer imitation with one set of stimuli that resulted in generalization to in-vivo sessions, two untrained sets, and increased attending and imitation during naturalistic play probes. The other two participants (Gabe and Brenna) learned to imitate one set of targets from the video model, however, their skills did not generalize to in-vivo conditions nor across sets. The experimenters were also not able to replicate the results of video model training within subject for subsequent training sets.

The results of the current study demonstrate some similarities to previous research. Sweeny et al. (2018) also observed prompt dependency among their autistic participants and subsequently implemented a differential reinforcement procedure for independent responses. Miles's performance was similar to participants in the Carr and Darcy (1990) study in that they saw generalization of imitation in post-training probes with novel stimuli. Sansing (2017) also found that, for two participants, video model training led to generalization of trained tasks to untrained task variations and moderate generalization to in-vivo conditions, but they did not see generalization from trained tasks to untrained tasks. We found similar results in Miles's data: video modeling training led to generalization to in-vivo conditions and across sets of stimuli (untrained task variations). Similarly, we did not see significant generalization to an untrained task which in the current study was the free play probe.

The experimenters have a few hypotheses as to why this procedure worked for Miles. For one, his peer was his sister. This meant that there were more opportunities for her to pair as a valuable model outside of the context of the imitation sessions. During in-vivo sessions, Molly would spontaneously provide praise for Miles's correct responses, and he would show indices of happiness in her direction when he completed the model correctly. Additionally, Miles did not engage in vocal stereotypy nor was the iPad® used as a reinforcing consequence during his ABA treatment.

The experimenters also have a few hypotheses for the lack of progress that Gabe and Brenna experienced. While the iPad® was originally hypothesized to improve attending to the relevant components of a video model (Bellini and Akullian, 2007), it appears that for Brenna, it could have hindered her performance. Anecdotally, Brenna would look at herself in the outer edges of the iPad® where she could see her reflection as she made faces or sang a song. Across participants and peers, it was also common that they would press the home button or tap the screen while the model was running. Thus, while autistic children may be more likely to attend to the iPad® because it has signaled reinforcement in the past (i.e., a discriminative stimulus) it is possible that repeated exposures without the presentation of the typical reinforcer such as a preferred video or game, resulted in conditioning the iPad® used by the experimenter to serve as an s-delta for watching it. The model, video or in-vivo, is a significant component of an imitation protocol as it should serve as the discriminative stimulus for engaging in a specific action; therefore, if the participant does not attend to it, it will not be conditioned as such. For this reason, it may be beneficial to assess attending to different types of models depending on the learner. For example, one of Brenna's preferred activities was looking at herself in the iPad® camera or a mirror, so the use of video self-modeling in which the participant serves as their own model might have been beneficial for her (e.g., Bellini et al., 2007; Buggey et al., 2011).

Another concern was that the stimuli used were too similar to toys and other items in their natural environment that had reinforcement history prior to participation in the study. For example, set two included a marshmallow on a stick that both Brenna and Gabe frequently reached for despite prompts to select another stimulus in the array. These play sets also included toy people and everyday items that the participants could have had access to in environments outside of research sessions. This history could have created a bias to respond to certain stimuli in the array (i.e., stimulus overselectivity; Ploog, 2010). We attempted to mitigate overselectivity by using multiple exemplar training and errorless teaching sessions, in addition to focused video models, however, Brenna and Gabe continued to respond to certain target stimuli. Future researchers could evaluate the efficacy of teaching a differential observing response (DOR) in the form of a vocal tact of the modeled play action such as "bedtime" while putting the boy in his bed. Using a vocal DOR may increase stimulus saliency of the model by drawing their attention to the relevant components and in turn reduce stimulus overselectivity (Halbur et al., 2021).

Finally, Brenna and Gabe both engaged in vocal stereotypy in the form of scripting. Vocal scripting is when an individual engages in repetitive vocalizations unrelated to the context, and it is often maintained by automatic reinforcement (Wunderlich & Vollmer, 2015). Although the experimenters completed formal tangible preference assessments and multiple within-session informal preference assessments with each participant, experimenters could not compete with the automatic reinforcers produced by vocal stereotypy. While a variety of tangible reinforcers were available for emitting a correct response, it was less effortful and possibly more reinforcing to engage in vocal scripting than to attend to and imitate the video model. Vocal stereotypy could have also interfered with attending because the vocal verbal behavior could elicit visual imagining (Skinner, 1974). For example, Brenna would sing songs from videos on YouTube and Gabe would spell. Thus, singing and spelling could elicit private images of the video or of letters which would preclude them from attending to the model. Future researchers may evaluate the efficacy of a DOR, as described earlier, as a competing behavior of vocal stereotypy.

Although Miles's peer imitation accuracy increased after video model training, there are a few limitations. The experimenters were unable to achieve replication within or across subjects, thus only an AB design was achieved. Because this design cannot control threats to internal validity, they cannot conclude that the video model treatment package was definitively responsible for behavior change.

Another limitation was that Miles behavior slightly decreased in maintenance. In-vivo and maintenance sessions did not include programmed reinforcement, thus it is possible that his behavior was decreasing because of extinction. Because it is likely that he would contact reinforcement for engaging in target behaviors throughout the rest of the clinic environment, it might have been warranted to include programmed reinforcement during maintenance sessions.

Additionally, Miles's behavior did not generalize to the free-play environment. The goal of teaching peer imitation is for the child to learn new skills through imitation in the natural environment, thus his results show the need for additional programming for generalization. It is possible that motivation to imitate the model during free play was low because he had the skills to play with the toys in a way that was reinforcing to him. Miles's attending improved after treatment; thus it is also possible that he observed the model and could have engaged in delayed imitation. Future research should use unfamiliar toys or items and ensure that the peer's model would demonstrate how to use them.

There are many directions for future research. Considering the hypothesis that attending was a deficit for Gabe and Brenna, it could be beneficial to evaluate the effects of an attending procedure has on peer imitation. Prior to their participation, the experimenters assessed which prompts would occasion attending to the live peer. In all cases, a gestural prompt was sufficient, however, over time the prompt became less effective for occasioning attending to the peer. It may be beneficial to intermittently reinforce attending alone to maintain this behavior. Future researchers could also assess the effects of a pairing procedure, such as those used to build rapport with new therapists (e.g., Lugo et al., 2017), to condition attending to peers during play as a pre-requisite skill for peer imitation. Experimenters could also capitalize on the natural opportunities for positive pairings that occur with siblings. Research using sibling-mediated interventions has shown that siblings can teach their autistic siblings play skills and imitation (e.g., Reagon et al., 2006; Walton & Ingersoll, 2012). Thus, replicating the current study with more sibling pairs may confirm the hypothesis that siblings have more positive pairings that contribute to their value as a model.

Finally, due to the lack of generalization to natural play and learning settings, natural environment teaching methods should be improved. While DTI procedures allow us to set up trials with salient models and measure total opportunities that free operant settings do not permit, the natural motivation to attend to and imitate a peer is likely, not present. Past research has used typical classroom materials like modeling dough (e.g., Ganz et al., 2008; Sweeney et al., 2018) to teach peer imitation in natural settings, however, these studies included school-aged individuals and the maintenance of the skill decreased when reinforcement was removed. Thus, one way to not only occasion attending, but to maintain behavior over time, would be to capitalize on naturally occurring motivation and reinforcement. This could be achieved through an interrupted chains scenario in which the target individual would need to gather information on how to create a desired effect with highly preferred play items by observing and imitating a peer's performance. Research on interrupted chains has primarily been used to target mands (e.g., requesting for help; Rodriguez et al., 2017), however seeking information through observation is another tool a learner can use to obtain a model for how to perform.

Overall, the goal of this study was to evaluate a treatment package to teach toddlers with autism to imitate their peers. While this teaching method was beneficial for one participant, it was not successful for the other two. This study extends research on this topic by incorporating DTI characteristics, however further evaluation is needed to determine the variables that contribute to the differences in performance across different learners.

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Table 1

Participant Characteristics

Participant	Age	Race/Ethnicity	MIS Score (Max 32)	VB-MAPP Milestones Score
Miles	2 years, 11 months	White	29	46.5
Gabe	3 years, 7 months	White	30	78.5
Brenna	4 years, 1 month	White	27	70

Peer	Participant	Age	Race/Ethnicity	VB-MAPP Milestones Score
Molly	Miles	4 years, 2 months	White	104
Suzy	Gabe	4 years, 6 months	White	76
Andrew	Brenna	4 years, 7 months	White	135.5

Table 2

Pre-Training and Training Targets

Generalized Imitation Probe Set	Set 1	Set 2	Set 3
Jump block	Pilot in Plane	Marshmallow over fire	Brush horse
Push rubber duck	Package in plane	Boy in bed	Jump horse
Fly character	Fly plane	Boy on log	Horse in stable

Table 3

Attending Assessment Descriptions

Prompt Name	Description (performed by experimenter)
Gestural	Use index finger to point to peer
Exaggerated gestural	Draw an invisible line from the target child's current eye line toward the peer
Physically-guide to point	Hand-over-hand guide the target child to point at the peer
Visual block	Make "C" shapes with hands and gently place on outside of the target child's face around their eyes

Figure 1: *Peer Imitation Training Data Across Participants*

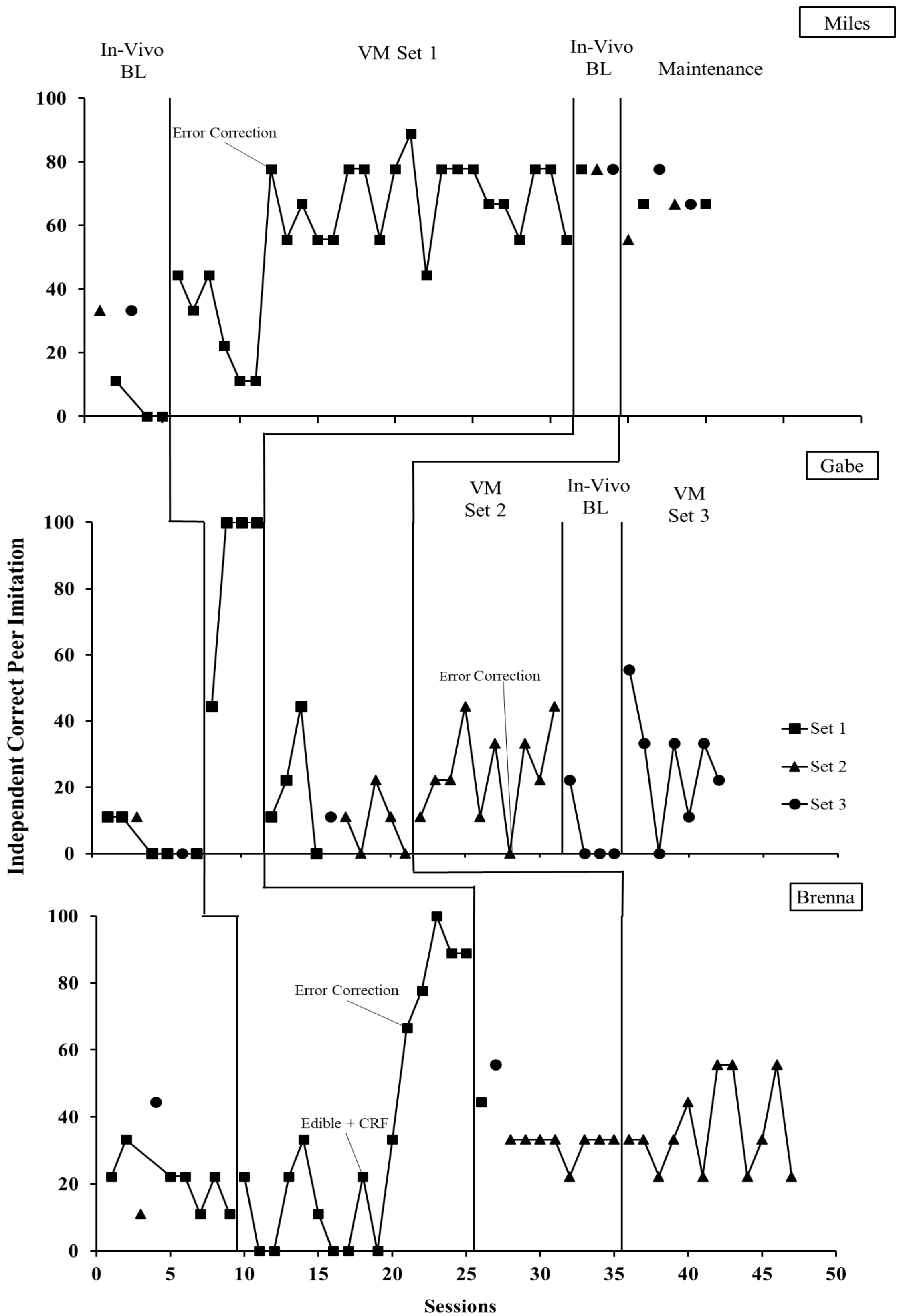


Figure 2: *Attending Data Across Participants*

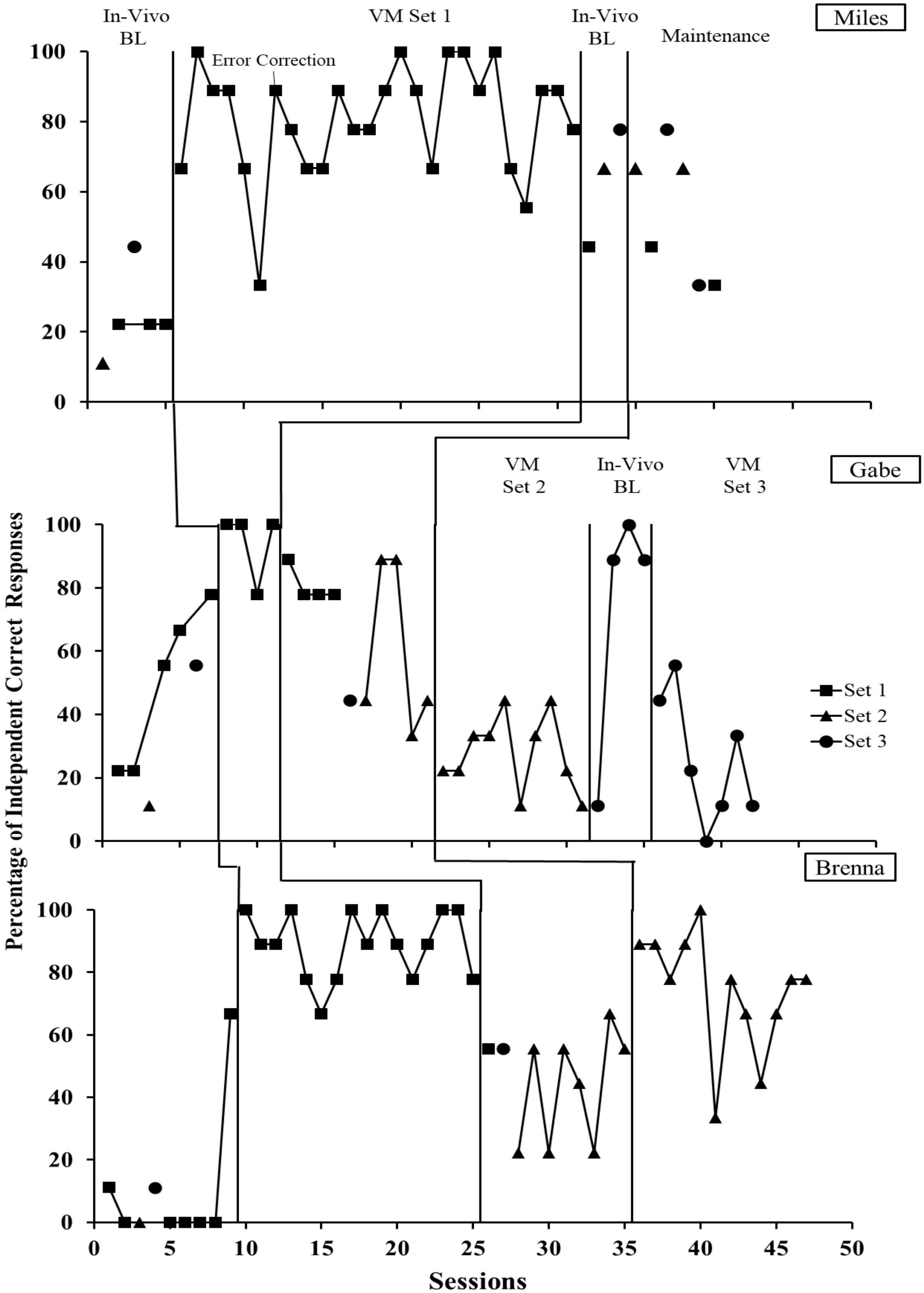
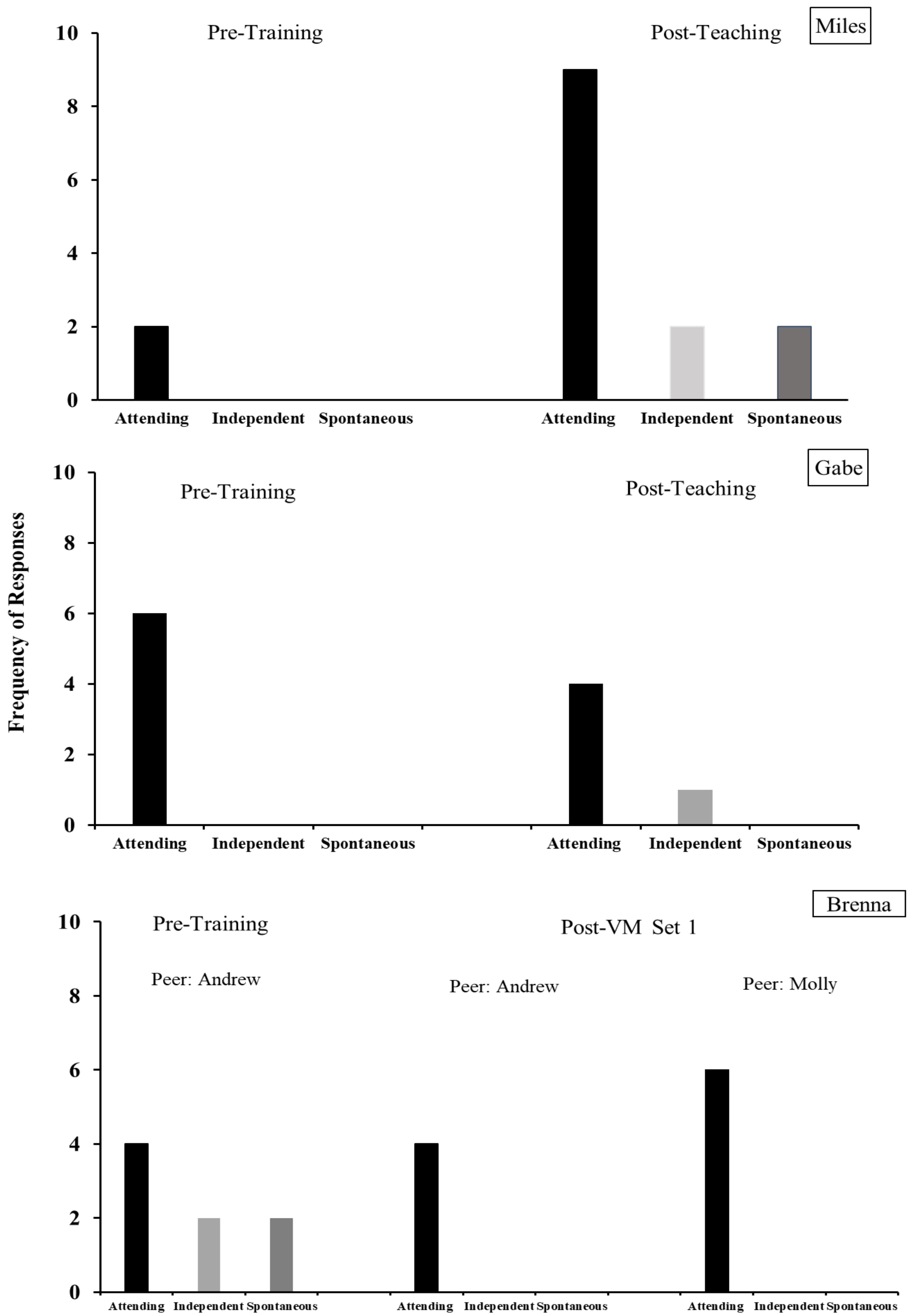


Figure 3: *Free Play Probe Data*



Appendix A: TI Measures Across Conditions for Target Therapist

Treatment Integrity Measures	
Response	**Definition**
Set-up	+ (correct): All stimuli are placed in the correct location. They are all placed on top of the white lid. - (incorrect): Any stimulus is placed in the wrong position. The items are not placed on top of the white lid.
Ensure Attending	+ (correct): If the child is not looking, therapist says "look" and provides the specified attending prompt toward the model. - (incorrect): The therapist does not say "look" and/or does not point to the model if child is not looking. N/A: The child is attending to the model.
Model 1	+ (correct): Therapist… • In-vivo sessions: provides the instruction "do what they did" within 2 s (+/- 1 s) of completion of the model. • Video model sessions: Therapist queues the video that corresponds to the number on the datasheet and provides the instruction within 2 s (+/- 1 s) of the completion of the model. - (incorrect): Therapist… • In-vivo sessions: does not provide the instruction within 2 s (+/- 1 s) of completion of the model. • Video model sessions: Therapist queues an incorrect video (one other than the one specified on the datasheet) or does not provide the instruction (as stated above) • All: therapist provides a prompt
Model 2	+ (correct): The therapist resets the trial and re-presents the VM within 5 s (+/- 1 s) of NR or an error. The therapist completes the instruction as described above. - (incorrect): The therapist does not re-present the trial within 5 s. The therapist does not complete the instruction as described above. N/A: Child engages in a correct response during VM instruction 1 or BL.
Model+Prompt	+ (correct)= Therapist delivers a correct prompt immediately following the 1st (0-s PD) or 3rd (5-s PD) presentation of the model (+ 1 s) -(incorrect) = Therapist does not deliver a prompt following the presentation of the model or provides the prompt after 2 s. NA = Child engages in a correct response in model 1 or model 2, or it is baseline.
Reinforcement delivery	+ (correct): Therapist …(must do all—when applicable) • Provides specified preferred items within 2 s of the specified response. • In-vivo/Baseline sessions: SR+ for mastered targets only; withhold praise and preferred items for correct target responses • NDR: edible and tangible for independent or prompted correct. • DSR+: tangible only for prompted correct. • Provides 30 s access to a tangible (+/- 5 s) - (incorrect): Therapist…(does any of the following) • Provides specified reinforcer more than 3 s after a specified response or does not provide one at all. • Provides access to a tangible for more than 35 s or less than 25 s.
Intersperse Mastered Tasks (baseline only)	+ (correct): The therapist presents a mastered task as least 3 times throughout the session. - (incorrect): The therapist presents less than four mastered tasks throughout the session. *On the TI datasheet, check off the trials that the therapist presents a mastered task.