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## The effects of animated video modeling on joint attention and social engagement in children with autism spectrum disorder

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### ABSTRACT

**Background:** The purpose of this study was to examine the efficacy of animated video modeling (VM) in promoting the acquisition and generalization of joint attention and social engagement in children autism spectrum disorder.

**Method:** Participants include six children ranging in age from 7 to 11 years old, each with Autism Spectrum Disorder. A multiple baseline design across participants was used to evaluate the relationship between the independent and dependent variables.

**Results:** Visual analysis of the results suggest rapid acquisition of both target skills and generalizing across settings and persons. Additionally, caregivers reported animated VM was a socially valid treatment.

**Conclusions:** Findings have several important implications regarding the use of animated VM as an intervention. Most importantly, animated video modeling may contribute to the rapid acquisition of joint attention and social engagement. Limitations and recommendations for future research are presented.

### 1. Introduction

Social communication skills refer to a range of verbal and nonverbal behaviors used in reciprocal social interaction (Trent, Kaiser, & Wolery, 2005). Acquisition of these skills marks important developmental milestones in the lives of children and leads to understanding of peer norms and relationships, as well as facilitates growth of intellectual, emotional, and academic skills (Landa, 2005). Research has consistently shown that social difficulties are common in children with developmental disabilities. For example, challenging behavior (e.g., inattention, tantrums) exhibited by children with Autism Spectrum Disorder (ASD) are often related to impaired verbal and nonverbal social communication skills (Spence, 2003). The presence of social communication deficits can impact school and often lead to isolation within complex social settings (Kasari, Locke, Gulsrud, & Rotheram-Fuller, 2011). Individuals with poor social communication skills are at increased risk for verbal and physical victimization (Kaukiainen et al., 2002).

The most effective interventions to enhance social communication skills are largely based on behavioral principles (Eikeseth, Smith, Jahr, & Eldevik, 2007). Intervention procedures used to teach social communication skills include: (a) discrete trial training (DTT; Eikseth et al., 2007; Lovaas, 1987; Smith, 2001); (b) naturalistic teaching (Cowan & Allen, 2007; Ingersoll & Schreibman, 2006; McGee, Almeida, Sulzer-Azaroff, & Feldman, 1992); and (c) visual teaching strategies (Bryan & Gast, 2000; Dettmer, Simpson, Myles, & Gantz, 2000; Krantz & McClannahan, 1993). In recent years, video modeling (VM) has emerged as an additional modality of

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treatment due to the abundant support found in research literature (e.g., Charlop & Milstein, 1989; Maione & Miranda, 2006; Paterson & Arco, 2007; Wert & Neisworth, 2003). This has been further facilitated by advanced technologies (e.g., iPads®, Amazon's Kindle Fire®).

VM has theoretical roots in social learning theory (Bandura, 1977), which suggests that children develop and engage in appropriate behaviors by learning which behaviors are likely to be reinforced or punished through social observation of others, then acting to achieve the most favorable consequences. In VM, an individual observes a video of predetermined target behaviors and is then directed to practice and imitate the stimuli from the video (Bellini & Akullian, 2007). There are several types of VM including adult, peer, self, and point-of-view models, all showing a video of live human(s) engaging in target behaviors (Gelbar, Anderson, McCarthy, & Buggey, 2012).

Researchers have found that VM is a more effective intervention than the more historically used in-vivo modeling. Charlop-Christy, Le, and Freeman (2000) compared the effectiveness of in-vivo modeling and VM. Within two conditions, individuals were instructed to observe a set of target behaviors and then demonstrate those behaviors. Four out of five children in the study acquired the behaviors faster under the VM condition than those under the in-vivo modeling condition. Additionally, the results also showed that VM led to higher generalization across settings, persons, and stimuli than did in-vivo modeling.

There is a growing body of research also supporting the effectiveness of VM. Meta-analyses have shown that VM is an effective strategy for teaching a range of skills including, social communication skills, functional skills, and behavioral functioning to children with varying ages (Bellini & Akullian, 2007; McCoy & Hermansen, 2007). More recently, Kabashi and Kaczmarek (2017) completed a systematic review, including 36 studies implementing VM to promote social functioning in ASD. In short, the authors noted strong support for the interventions across the literature. For example, Charlop, Dennis, Carpenter, and Greenberg (2010) recently evaluated the effectiveness of VM (using adult models) in the teaching of complex socially expressive behaviors (i.e., verbal comments, intonation, gestures, facial expressions) to three children, ages 7–11 years, diagnosed with of ASD. Using a multiple baseline design across participants to assess the effects of VM intervention, the researchers found that the intervention promoted the target responses for all three participants. The participants also demonstrated generalization across settings, persons, and stimuli. Further, participants acquired the skills rapidly with two of the participants reaching the criterion on all four target responses within four treatment sessions and the last one reaching criterion in five treatment sessions. Rex, Charlop, and Spector (2018) used a similar design to teach six children with ASD how to appropriately respond to bullying. Four of the participants demonstrated acquisition of the skill during a bullying a scenario.

Despite the substantial support for VM, there are concerns about the feasibility and ease of implementation (e.g., time and cost to produce training videos, the need for technical knowledge and equipment to produce videos; Bellini & McConnell, 2010). When using peers as models within VM, time management and cost are significant issues. Additionally, when peers as used as models editing to extract teacher prompts and off-task peer model behavior is needed (Apple, Billingsley, & Schwartz, 2005). Self-model VM also requires an extended amount of time to film and edit the videos (Hitchcock, Dowrick, & Prater, 2003). While these potential shortcomings have been identified independently in the literature, collectively they provide evidence for practitioners to consider alternative options. Taking these concerns under consideration, traditional VM may be effective, but it may not be the most efficient tool for wide implementation.

One potential solution to these shortcomings of VM, is the use of animated videos. For example, animated videos may be created through online programs; thereby minimizing the need for technical knowledge and specialized equipment and software, beyond basic computer skills. Many online programs offer templated models, requiring users to simply select amongst pre-programmed options and “drag and drop” options. Further, programs often come equipped with text recognition allowing users to type specific scripts. Finally, step-by-step instructions and tutorials are readily available. Additionally, other limitations such as time constraints and difficulty in locating age- and gender-matched model may be avoided with animated VM (Bellini & McConnell, 2010).

Keen, Brannigan, and Cuskelly (2007) evaluated the effectiveness of animated VM for teaching toileting skills to five young children with ASD. The treatment condition supplemented reinforcement with animated VM, while the control condition only had reinforcement. The animated VM was a 6-min video of toileting prior to each toilet use and simple verbal instructions to provide the sequence of toileting steps in a logical order. Participants under the treatment condition demonstrated higher frequency of in-toilet urinations and a more consistent pattern of in-toilet urination than those under the control condition. Thus, it is unclear to what degree animated VM facilitated the overall acquisition of toileting skills or whether animated VM can serve as an effective stand-alone intervention in teaching toileting skills without the need for operant conditioning strategies.

Collectively, the literature provides substantial evidence supporting VM based interventions. More specifically, using technology (i.e., a video model) in a controlled and purposeful intervention, can improve social interactions in a multitude of ways for individuals with ASD. That is not to say that simply placing children with ASD in front of a screen leads to positive outcomes. For example, Healy, Haegele, Grenier, and Garcia (2017) noted that children with ASD were more likely than same-aged peers without ASD to use screen-based technology more frequency and more likely to be obese. In a similar vein, children with developmental disabilities who engage in greater daily screen time activities are at great risk for sleep concerns than children who engage in less screen time-based activities (Aishworiya, Kiing, Chan, Tung, & Law, 2018). However, VM interventions involved planned and targeted exposures to improve pro-social responding in the outside world.

Given supporting evidence for VM as an effective tool to teach social skills (e.g., Charlop, Gilmore, & Chang, 2008; Charlop-Christy et al., 2000; Charlop-Christy & Carpenter, 2000; Charlop-Christy & Daneshvar, 2003; Rex et al. (2018) and the more recent support of animated VM for improving behavior, the goal of the current study was to further explore the use of animated VM for improving social skills. Specifically, the current study adapted the methodology of Charlop et al. (2010), to evaluate the efficacy of animated VM in teaching two social communication skills: joint attention and social engagement. The current study also included an

assessment of pre-requisite skills that may be required for animated VM interventions, often not reported in other VM studies.

## 2. Method

### 2.1. Participants and setting

Purposive sampling (Leedy & Ormrod, 2005) was used to recruit potential participants from two separate primary care clinics in the midwestern United States. The clinics primarily served individuals with ASD. Selection of six participants (ages 7–11 years) with ASD was made based on reported social communication problems by parents, and by information gathered from pre-participation assessments to confirm reported problems. ASD diagnoses made by qualified health professional were confirmed from a medical record review. Pre-participation assessments, as well as baseline, treatment, play, and generalization sessions were conducted in clinic treatment rooms. During the sessions, only the materials needed for the study were present, as well as the participant and interventionist. The primary investigator, an advanced doctoral student in school psychology, acted as the lead interventionist for each participant. Secondary interventionist were also graduate students assisting on the project.

#### 2.1.1. Ben

Ben, an 8-year-old Caucasian male third grader with delayed speech, presented with behavioral concerns including non-compliance and aggression. Per report, he was born premature, and had comorbid diagnoses of ADHD, Oppositional Defiance Disorder (ODD), and ASD.

#### 2.1.2. Brandon

Brandon, an 8-year-old Caucasian male second grader with delays in several areas (e.g., motor, toileting, speech/language), presented with behavioral concerns (i.e., aggression, anger outbursts, and noncompliance) and a history of social concerns (e.g., lack of affection for others, peer difficulties, understanding social boundaries). Brandon has a comorbid diagnosis of ADHD – Predominantly Inattentive Type and ASD.

#### 2.1.3. Zane

Zane, a 9-year-old Caucasian male third grader with delays in toileting, presented with behavior concerns (e.g., outbursts, aggression, property destruction). Per medical reports, he was born with a Nuchal cord and diagnosed with ASD at age of 4 years.

#### 2.1.4. Cory

Cory, an 11-year-old Caucasian male fifth grader with delays in several areas (e.g., motor, toileting, speech/language), presented with significant problem behaviors (e.g., property destruction, defiance, outbursts, self-injury, aggression, inattention, perseveration, echolalia). Per medical records, he had 11 surgeries due to multiple medical conditions and has comorbid diagnoses of ADHD – Combined Type and ASD.

#### 2.1.5. Zander

Zander, a 7-year-old Caucasian male second grader with delays in most areas (e.g., fine and gross motor, toileting, speech/language), presented with behavioral concerns (e.g., noncompliance, outbursts, aggression, attention difficulties). Based on medical records, he had a complicated medical history and a diagnosis of ASD.

#### 2.1.6. Nancy

Nancy, a 7-year-old Hispanic American female first grader with delays in speech/language, presented with problem behaviors (e.g., outbursts, aggression). School records showed an eligibility category of ASD.

## 2.2. Materials

Materials included a video recorder, iPad®, tangible reinforcers, and two assessment instruments used to screen participants for inclusion in the study. These instruments included: (a) Vineland Adaptive Behavior Scale, Second Edition, Survey Interview Form (Vineland – II SIF; Sparrow, Cicchetti, & Balla, 2005); and (b) Motor Imitation Scale (MIS; Stone, Ousley, & Littleford, 1997). The Treatment Acceptability Rating Form – Revised (TARF-R; Reimers & Wacker, 1992) was also included as a measure of social validity and administered at the completion of the study.

### 2.2.1. Vineland adaptive behavior scale, second edition, survey interview form

The Vineland – II SIF is a structured interview scale that assesses the individual's overall level of adaptive functioning, as well as the individual's adaptive functioning in more distinct areas. The Vineland – II SIF contains 11 subdomains that are grouped into four domain composites: Communication, Daily Living Skills, Socialization, and Motor Skills. Each domain has a composite score with a mean of 100 and standard deviation of 15. Scores that are in 70–80 range indicates borderline adaptive functioning; 51–70 indicates mildly deficient adaptive functioning; 35–50 indicates moderately deficient adaptive behavior; 20–35 indicates severely deficient adaptive behavior; and less than 20 indicates markedly or profoundly deficient adaptive behavior.

The Vineland – II SIF (Socialization and Communication domains) was administered to parents in an interview format to evaluate

areas of socialization and communication. According to Sparrow et al. (2005), the internal consistency data for the Vineland – II SIF were calculated using split half means and range from 0.83 to 0.90 for the domains, and 0.94 for the Adaptive Behavior Composite. Additionally, test-retest reliability was 0.80 to 0.86 for the domains and 0.88 for the Adaptive Behavior Composite ( $N = 484$ ). Interrater reliability ranged from 0.62 to 0.78 for the domains and was 0.74 for the Adaptive Behavior Composite ( $N = 160$ ).

### 2.2.2. Motor imitation scale

The MIS (Stone et al., 1997) was originally developed for a comparative study investigating the nature of motor imitation patterns in young children with autism, children who were development delayed, and neurotypical children. The MIS contains 16 items that elicit single-step motor imitation skills. Half of items consist of tasks that require the manipulation of objects. The remaining half of items involve body movement tasks. The MIS was administered within a structured context in which each imitation item is provided by the examiner with the instructions to “Do this” or “Do what I do,” without labeling the action. The MIS total score ranges from 0 to 32.

Psychometrically, the MIS has strong interobserver agreement, high test-retest reliability, and strong internal consistency (Stone et al., 1997). Specifically, Cohen’s kappa, which collapsed across items and subjects, was reported to be 0.80, indicating very good interobserver agreement. Test-retest reliability was conducted during a 2-week period and calculated for an independent sample of ( $N = 30$ ) children with varied diagnoses (i.e., ASD, Pervasive Developmental Disorder – Not Otherwise Specified, Developmental Delay, Language Disorders, and Behavior Disorders). The result of test-retest reliability was 0.80 for the MIS total score, indicating high test-retest reliability. Finally, internal consistency was calculated for the total MIS score, as well as scores obtained for body imitation, object imitation, and meaningful and non-meaningful tasks ( $N = 54$ ). The results demonstrated strong internal consistency with standardized alpha coefficient was found to be 0.87. Standardized alpha coefficient for other dimension ranged from 0.54 to 0.88.

### 2.2.3. Treatment acceptability rating form – revised

The TARF-R is an instrument used to measure acceptability of treatments devised within clinical settings and is a revised expanded form of the Treatment Acceptability Rating Form (Reimers & Wacker, 1992). The TARF-R consists of 20 questions, 17 of which pertain to treatment acceptability, 2 questions address problem severity, and 1 question addresses understanding of the intervention. The items are rated on a 7-point Likert-type scale with varying anchor point descriptors each for item. The total scores are obtained by summing all items, with higher summed scores representing greater levels of acceptability. The items are organized into composites tapping a number of dimensions in acceptability including reasonableness, effectiveness, side effects, disruptive/time, cost, and willingness.

Reimers, Wacker, Cooper, and DeRaad (1992) administered the TARF-R to 40 families seeking outpatient services following implementation of treatments. The results found an overall alpha coefficient of 0.92, indicating excellent internal consistency reliability for the full-scale measure. Also, internal consistency reliability was found to range from 0.69 to 0.95 for all composites, indicating good to excellent composite reliability. The construct validity of the TARF-R was also investigated in a study that included 90 parents who were asked to evaluate treatment effectiveness following the presentation of a case description of a child with clinical concerns (Reimers, Wacker, & Cooper, 1991). The results using factor analysis found the items to load highly on to their respective factors, indicating that the TARF-R demonstrated good construct validity. For the current study, the TARF-R was administered to parents to assess social validity of treatment following the intervention.

## 2.3. Independent variable

The independent variable was the animated VM. Videos were developed with an online program (i.e., <http://www.goanimate.com>) that requires minimal technical knowledge, and is a cloud-based platform that develops both narrative videos (i.e., characters speak with lip-sync) and video presentations with a voiceover narration.

A set of three animated scenarios were developed as a video for each participant. Each scenario demonstrated a situation in which it was appropriate for the participant to engage in joint attention and social engagement. Scenario 1 depicted a situation in which the model requested a preferred toy; Scenario 2 showed a model requesting for a preferred edible item; and Scenario 3 portrayed a model requesting for help to open a box with a preferred toy or edible item inside. The videos were similar for all participants with differentiation of the model (e.g., matched to physical characteristics of the individual participant) and the toys and/or edible items individually identified via a preference assessment. The preferred items were also used during play sessions. Videos were developed using third-person scene perspective and actions occurred at a slow pace, as suggested by previous research (Charlop et al., 2008, 2010).

## 2.4. Dependent variables

The two dependent variables were joint attention and social engagement. In the literature, joint attention is often defined as the ability to coordinate attention with a social partner and event (Clifford & Dissanayake, 2009). Social engagement is defined as inadequate motivation to display certain social skills during certain social situations, although the child possesses the necessary skills for appropriate interactions (Gresham, Sugai, & Horner, 2001). For the purposes of the current study, joint attention was defined as shifting gaze between an object/event and another person within 5s of providing the discriminative object/event by a clinician. Social engagement was defined as any self-initiated, independent motor or vocal behavior directed toward another to begin social

interaction such as asking for help or taking the adult by the hand.

## 2.5. Design of study

A non-concurrent multiple baseline design with baseline and replication across participants was used to assess the effects of animated VM treatment on each targeted social behavior. [Watson and Workman \(1981\)](#), first noted the benefits of a non-concurrent baseline design for participants whose data are collected at different points time. More recently, [Christ \(2007\)](#) noted similar adequacy in experimental control across non-concurrent and concurrent designs. Further, [Christ \(2007\)](#) discusses the benefits of using non-concurrent multiple baseline designs when it may be difficult to run participants at similar points in time, as long as a priori decision rules are made about phase changes. He also notes the merits of additional participants to replicate the hypothesized effect. Unfortunately, there is limited guidance on how far apart in time participants needs to be before a concurrent multiple baseline design because a non-concurrent design.

In efforts to follow the recommendations of [Christ \(2007\)](#), the participants were considered non-concurrent, with a priori rules based on [Charlop et al. \(2010\)](#). All participants data were collected within the same three-week period. Participant order was based on recruitment order. The first participant's baseline rule consisted of having at least three stable data points in a trend that was neutral or opposite of the hypothesized effect. Each subsequent participant remained in baseline until the immediately preceding participant reached mastery (i.e., 7 out of 9 trials correct; [Charlop et al., 2010](#)) or discontinued (i.e., 15 sessions of no effect; [Kroeger, Schultz, & Newsome, 2007](#)). The procedure was identical across baseline, play (described next), and generalization (i.e., across different adults and settings) sessions. Each participant was involved in the study between two and seven days, depending on their baseline and intervention condition lengths. During each day, three to five session data points were collected. Social validity of treatment was assessed to evaluate parents' impressions of acceptability and practicality of the animated VM intervention to enhance social skills.

## 2.6. Procedure

### 2.6.1. Pre-participation assessments

Pre-requisite skills assessments evaluated the following: (a) parent-reported problems with social communication skills, confirmed by the Vineland – II SIF (criteria of below 70 on the Socialization and Communication subscales); (b) problems with the two target social communication skills, as evaluated by a semi-structured assessment; (c) parent-reported vision and hearing acuity within normal or corrected ranges; (d) ability for basic imitation skills assessed with the MIS; and (e) ability to visually attend to a video for 1 min.

A semi-structured assessment, adapted from [Dykstra, Boyd, Watson, Crais, and Baranek \(2012\)](#), was used to confirm social deficits and included the following: (a) 10 min of naturalistic observation of engagement in one-on-one play scenarios with an adult to elicit the target social skills (i.e., joint attention and social engagement). Specifically, the adult initiated interaction by presenting toys or activities. The participants were given 5 s to display the target responses (e.g., eye contact and/or verbal or motor behavior to engage in play). If the participant displayed the target, he or she was provided with reciprocal responses from the adult, per [Dykstra et al. \(2012\)](#). The target social responses were qualitatively evaluated through observation and the frequency of the target responses was also recorded. Parent interviews confirmed the skill deficit as appropriate and meaningful. Each participant needed to be able to: (a) see and hear the animated video and (b) to imitate the content of the video. Imitation ability was assessed with the MIS (minimum score of 17). Visual attention was determined by having the child watch an unrelated animated video of individuals performing a task or engaging in a social situation on an iPad® for 1 min. The total attention time was recorded for later use in the development of a treatment video. The participant was included in the study if he or she met other previously identified criteria and was able to attend to and watch the video clip for at least 1 min.

### 2.6.2. Selection of reinforcers

Prior to the development of the video for each included participant, the parents were asked to identify a list of preferred reinforcers. Then, a multiple-stimulus without replacement (MSWO; [DeLeon & Iwata, 1996](#)) preference assessment was conducted to determine the preferred stimuli. The items were then ranked by order of selection and the three highest ranked items were embedded in the context of the animated videos and used as the reinforcers for achieving target responses during play sessions.

### 2.6.3. Baseline sessions

After the initial assessments, baseline sessions were conducted to evaluate the participants' joint attention and social engagement in response to the discriminative stimuli. As indicated, methodology for baseline, treatment, play, and generalization sessions was adapted from the [Charlop et al. \(2010\)](#) study and were the same across all sessions. At the start of each baseline session, the researcher presented one of the discriminative stimuli (e.g., playing with Lego®) and created a situation in which it was appropriate for the participant to engage in the target responses (i.e., joint attention and social engagement). The participant was then given 5 s to emit the target appropriate response (e.g., make eye contact, verbally ask or gesture to play). The trial was terminated if no response occurred within 5 s, and the participant returned to his or her previous free play activity. If the appropriate target response(s) was provided, it was reinforced with an appropriate reciprocal response (e.g., eye contact, an offer to play). Each 5-min baseline session contained nine trials or opportunities for the participant to display the target responses, with three opportunities for each of the three discriminative stimuli. The nine opportunities were presented intermittently throughout the 5-min of free play.

#### 2.6.4. VM treatment sessions

At the beginning of the treatment session, each participant was asked to sit quietly on a chair and watch the personalized animated video on an iPad<sup>®</sup>. Visual attention to the video was continuously monitored. Inattentiveness (i.e., eye contact breaks from video for more than 3 s) was immediately redirected to ensure attention to the video. The participant watched the video three consecutive times.

#### 2.6.5. VM play sessions

To examine the effects of the treatment sessions, the participant was immediately escorted to a nearby room and observed during a 5-min play session. To initiate interaction the discriminative stimuli (e.g., preferred toy) was presented in similar manner to that depicted in the animated video. The participant was then given 5 s to display the appropriate target responses (e.g., eye contact, ask to join in, use a gesture indicating a desire to play). Identical to baseline, the trial was terminated if the participant did not display the appropriate target responses within 5 s. If the participant emitted the target response(s), the response was reinforced with appropriate reciprocal responses. The play sessions proceeded identical to baseline with nine opportunities for interaction provided intermittently during the free play session. Per Charlop et al. (2010), as long as participants met criterial (i.e., 7 out of 9 trials correct), they remained in play sessions. However, if criteria was not met after the first two session, receiving three additional exposures to the video as outline in VM treatment session.

#### 2.6.6. Generalization sessions

Generalization was assessed following the achievement of performance criterion for the target across three sessions. Prior to generalization probes, participants were randomly assigned to one of two generalization groups: three participants to the Person group (i.e., with an unfamiliar adult in the same room) and three participants to the Setting group (i.e., in an unfamiliar room but same adult). The stimuli and procedures used during generalization sessions were similar to those in play sessions.

#### 2.7. Data collection

During baseline, play, and generalization sessions, a video recorder was used to record the target behaviors in response to each discriminative stimulus (e.g., a preferred toy). Each session video was scored by trained research assistants. The participants received a separate score for each of the target behaviors for each session with nine opportunities or trials per session. A trial was scored as correct if the participant displayed the target or similar appropriate responses. Scores for each session were calculated by dividing the number of correct target responses by nine (i.e., total number of trials or opportunities).

The performance criterion was seven out of nine trials (approximately 78%) in which the target responses were displayed for at least two consecutive sessions. The participant was required to watch the treatment video again if he or she did not meet performance criterion after the first two sessions and in any subsequent sessions if performance criterion was still not met. If the participant showed that he or she was not able to achieve performance criterion within 15 sessions (Kroeger et al., 2007), the researcher discontinued the intervention. Following the intervention condition, generalization probes across person and setting were conducted to assess generalization of treatments effects. As indicated, data collection procedures for generalization probes were identical to baseline and play sessions.

#### 2.8. Data analysis

In addition to the evaluation of performance criterion set forth by the Charlop et al. (2010) study, visual analysis using the standards suggested by Kratochwill et al. (2010) were conducted to evaluate the efficacy of the intervention. For multiple baseline designs, this included analysis of level, trend, variability, patterns across similar phases, overlap, immediacy of effect, and vertical comparisons across participants. Effect size was calculated using the percentage of non-overlapping data points (PND) with criteria suggested by Scruggs and Mastropieri (1998). Specifically, PND over 90% is highly effective, 70%–89% is moderately effective, 50%–69% is questionable, and below 49% is ineffective treatment. For generalization probes, data were also visually inspected to determine the extent to which the target behaviors were generalized to different persons and settings. Generalization performance was also evaluated (i.e., met criterion for two of three sessions) and PND was calculated.

#### 2.9. Procedural integrity

Procedural integrity was measured for baseline, play, and generalization conditions. An independent, trained observer watched randomly selected videos to evaluate if the steps were implemented with reliability (e.g., trials presented consistent with procedures, no extraneous prompts). Thirty-three percent of total baseline (25), play (9), and generalization (5) sessions were randomly selected and rated by another observer using an integrity a checklist. Baseline, procedural integrity was acceptable for all sessions: (a) baseline was 87.50%–100.00% ( $M = 95.50\%$ ), play session was 87.50%–100.00% ( $M = 94.40\%$ ) and generalization was 87.50%–100.00% ( $M = 95.00\%$ ).

#### 2.10. Interobserver agreement

All research assistants collecting inter-observer agreement (IOA) were school psychology graduate students blind to the study's

hypothesized effects. Each were trained on the operational definitions of the specific variables and then required to meet a minimum of a 90% IOA agreement with the lead author on a series of training videos. Once this minimum was met, they were allowed to collect IOA data. If the average IOA fell below 90% at any time, the principal investigator reviewed the videos and the operational definitions of the target behaviors with the rater. The primary interventionist's data were used for decision making purposes.

The independent, trained rater simultaneously observed and scored randomly selected videos for all sessions (i.e., baseline, play, generalization). All videos were collected via a clinic room recording system. Cameras were installed in all treatment rooms allowing for a panoramic view of the entire room, along with angles of the clients' and clinician's faces. A total of 38 sessions (i.e., approximately 33% of all sessions) were randomly selected for IOA. The IOA for joint attention was 55.56%–100.00% ( $M = 90.35\%$ ), social engagement calculated separately was 66.67%–100.00% ( $M = 93.27\%$ ). Overall, there were five times when IOA unacceptable. These videos were reviewed by the principal investigator and the rater to reach a consensus for the most correct scoring.

### 3. Results

Overall, results were analyzed using visual analysis standards suggested by Kratochwill et al. (2010). To complete the visual analysis procedures, the percentage of trials the target skills were correctly done during each session was graphed (see Figs. 1 and 2) for each of skill (i.e., joint attention, social engagement) across the participants. Notably, Zander and Nancy had disproportionately long baseline sessions. This was a direct effect of the established criteria for moving from baseline to intervention, which was the immediately preceding participant needs to reach mastery or meet the discontinue of treatment rule.

Overall, five out of six participants demonstrated rapid acquisition of both joint attention and social engagement skills, as evaluated via achievement of performance criterion (range = 2–4 sessions for both target skills). All participants displayed an increase in both joint attention and social engagement relative to baseline following treatment (see Tables 1 and 2). Visual analysis for joint attention shows baseline phases with low levels, neutral trends, and stable data. With the exception of Cory, intervention phases were characterized by an immediate increase in level, neutral or increasing trends, stable data, and no overlap with baseline conditions. Vertically, when moving into intervention phase, the subsequent participants baseline data remained stable and at baseline rates. When considering the social engagement data, a similar pattern of results emerged across the participants; however, baseline levels are slightly higher for Zane, Zander, and Nancy relative to their joint attention data. Fortunately, for both joint attention and social engagement, there is a replication of the effect across at least three participants, which meets outcome standards per Kratochwill et al. (2010).

In addition, five of six participants had treatment PNDs of 100% for both target skills, indicating animated VM was a 'highly effective' intervention (Scruggs & Mastropieri, 1998) for these participants. The one participant who did not, Cory, had treatment PNDs of 33% (ineffective) and 67% (questionable) for joint attention and social engagement, respectively. Generalization across setting was found for three participants and across person for the other three participants. However, generalization probes for setting were conducted for only two participants because one participant, Cory, did not meet performance criterion, and intervention was discontinued after 15 treatment sessions. For those for whom generalization probes were conducted, the results support generalization of acquired skills beyond the intervention setting and person for some of these participants (see Table 3).

### 4. Discussion & implications

The purpose of current study was to examine the efficacy of animated VM as an independent intervention tool in teaching acquisition of two important social communication skills: joint attention and social engagement. Overall, results showed that five of six participants demonstrated rapid acquisition of joint attention and social engagement skills and that these improvements typically occurred within two to four sessions. Specifically, of the five participants presented with VM who met performance criterion (i.e., approximately 78% of opportunities correct for two consecutive sessions), only Brandon required more than two sessions to achieve the study's performance criterion for joint attention skill and all five met performance criterion for social engagement in two sessions.

Overall, findings from the current study provide adequate preliminary support for animated VM as an intervention to promote acquisition of joint attention and social engagement skills. All but one participant displayed rapid acquisition of the target behaviors. The rate of acquisition is consistent with the findings from the Charlop et al. (2010) study, in which the current study's methodology was adapted. Specifically, all three participants in the Charlop et al. (2010) study reached performance criterion on an average of four treatment sessions. Review of literature also found previous studies using VM to have similar acquisition rates as the current study (Bellini & Akullian, 2007; Buggey, 2005; Charlop & Milstein, 1989; Charlop-Christy et al., 2000; Nikopoulos & Keenan, 2007),

Of the five participants for whom generalization probes were conducted, all achieved performance criterion for social engagement skill. For joint attention, three of the five participants met the criterion with only Brandon and Nancy, each of whom did not consistently demonstrate the skill with a different adult. Overall, generalization results somewhat varied for the participants and the target behaviors; however, all children demonstrated both target behaviors at higher rates than during baseline. These findings are mostly consistent with the generalization results of Charlop et al. (2010).

With regards to the response variation between the two target skills in which social engagement skill is better generalizable than joint attention skill, one explanation may be that joint attention is a more difficult skill to learn and then generalize than social engagement. Joint attention is a foundational yet complex skill that involves the coordination of several behaviors, including gaze alternation, gesture, and/or verbalization. Previous researchers have found that acquiring such skill is challenging for children with ASD (Mundy, Sigman, Ungerer, & Sharman, 1986), as was the case with Brandon and Nancy. Even for those who acquired the skill, it may be especially challenging when having to demonstrate these skills consistently within a limited time frame (i.e., three

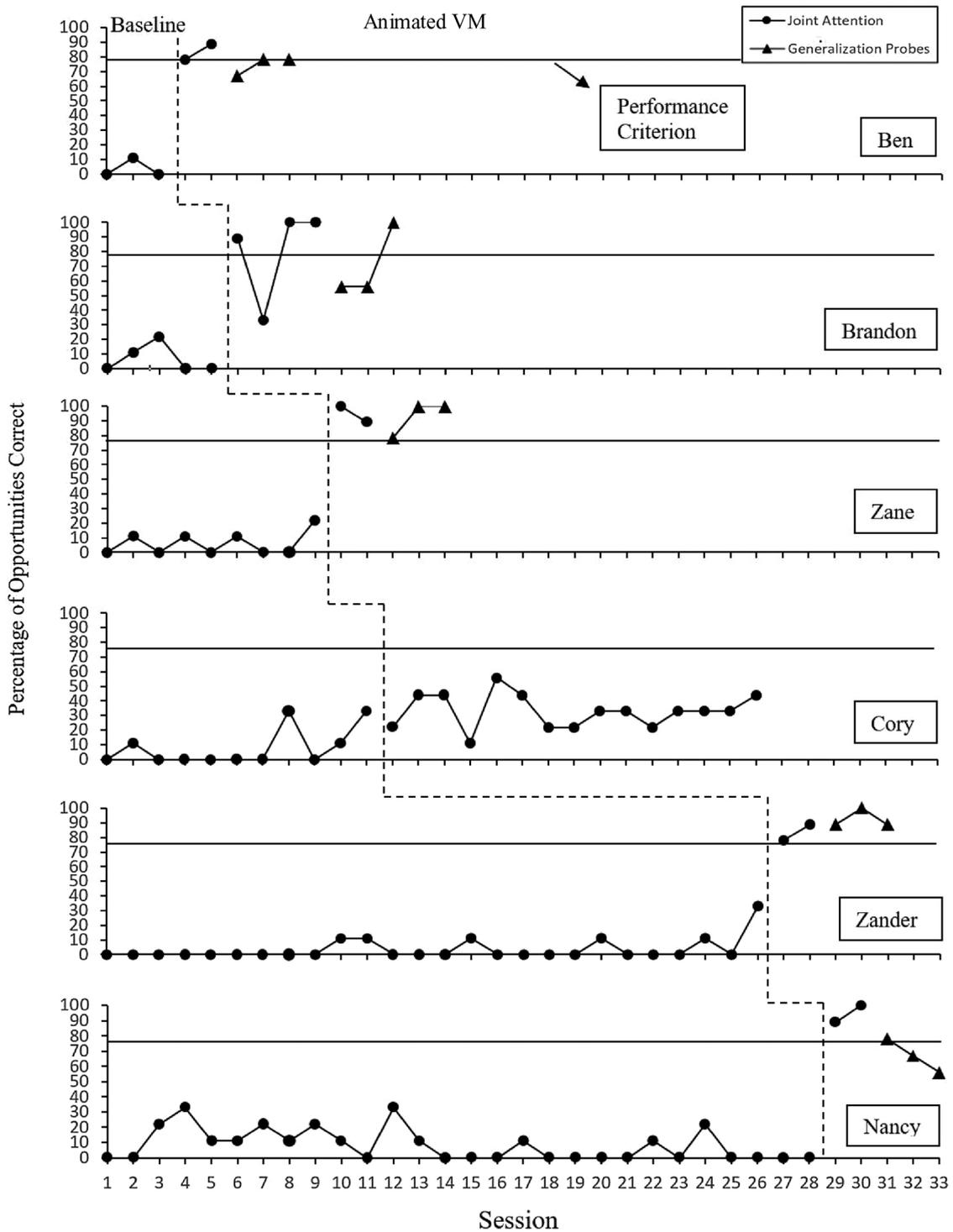


Fig. 1. Percentage of opportunities in which joint attention skill was exhibited during baseline, treatment, and generalization (i.e., setting and person) for all six participants.

generalization probes). Overall, although the generalization results varied for the five participants who achieved performance criterion, all of these participants demonstrated both target skills at higher rates than during baseline.

A few explanations may be offered about the response variation during generalization among participants as well as between target skills. One, it is likely that learning rate may be different for each participant. Although three participants were able to rapidly acquire joint attention skill and subsequently generalize this skill across person or setting as shown within the three generalization

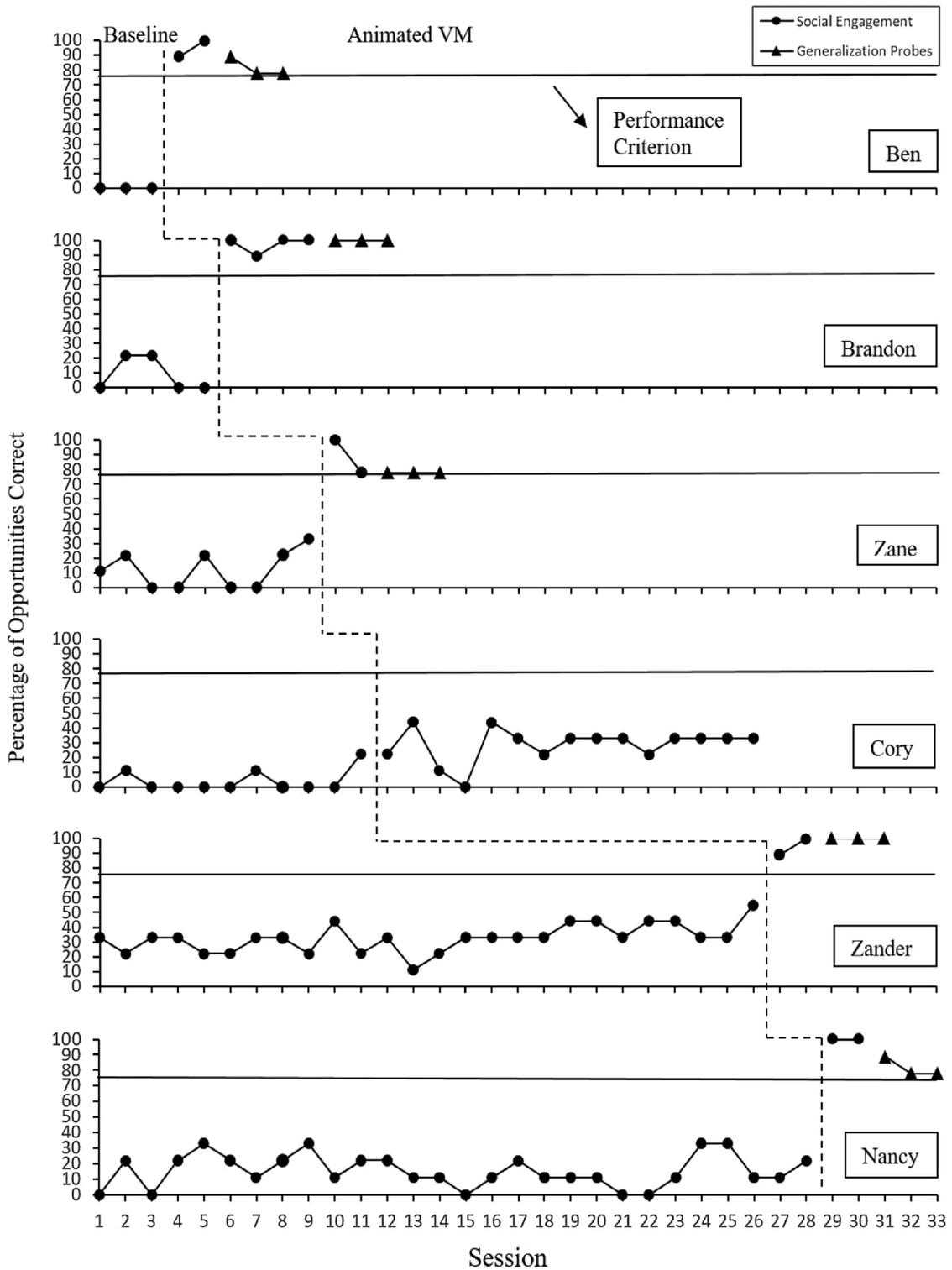


Fig. 2. Percentage of opportunities in which social engagement skills were exhibited during baseline, treatment, and generalization (i.e., setting and person) for all six participants.

probes, it may have taken longer for Brandon and Nancy to demonstrate this skill with a different person or adult. Specifically, in the case of Brandon, data indicated an increasing trend in skill demonstration during generalization. Thus, it is possible he could have consistently exhibited joint attention if generalization probes were conducted for more than three sessions. While Nancy

**Table 1**  
Summary Statistics of Joint Attention Skill for Each Participant.

| Participant | Baseline Average Percentage | Performance Criterion | Number of Treatment Sessions for Criterion | Treatment Average Percentage |
|-------------|-----------------------------|-----------------------|--|------------------------------|
| Ben         | 3.67%                       | Yes                   | 2  | 83.50%                       |
| Brandon     | 6.60%                       | Yes                   | 4  | 80.50%                       |
| Zane        | 6.10%                       | Yes                   | 2  | 94.50%                       |
| Cory        | 8.00%                       | No                    | *  | 33.07%                       |
| Zander      | 3.38%                       | Yes                   | 2  | 83.50%                       |
| Nancy       | 5.50%                       | Yes                   | 2  | 94.50%                       |

Note. \* = Indicates not meeting performance criterion for joint attention skill.

**Table 2**  
Summary Statistics of Social Engagement Skill for Each Participant.

| Participant | Baseline Average Percentage | Performance Criterion | Number of Treatment Sessions for Criterion | Treatment Average Percentage |
|-------------|-----------------------------|-----------------------|--|------------------------------|
| Ben         | 0.00%                       | Yes                   | 2  | 94.50%                       |
| Brandon     | 8.80%                       | Yes                   | 2  | 97.25%                       |
| Zane        | 12.22%                      | Yes                   | 2  | 89.00%                       |
| Cory        | 4.00%                       | No                    | *  | 28.60%                       |
| Zander      | 32.58%                      | Yes                   | 2  | 94.50%                       |
| Nancy       | 15.32%                      | Yes                   | 2  | 100.00%                      |

Note. \* = Indicates not meeting performance criterion for social engagement skill.

**Table 3**  
Summary of Generalization Results.

| Participant | Joint Attention |                         |                    | Social Engagement |                         |                    |
|-------------|-----------------|-------------------------|--------------------|-------------------|-------------------------|--------------------|
|             | Type            | Number of Criterion Met | Average Percentage | Type              | Number of Criterion Met | Average Percentage |
| Ben         | Person          | 2                       | 74.33%             | Person            | 3                       | 81.67%             |
| Brandon     | Person          | 1                       | 70.67%             | Person            | 3                       | 100.00%            |
| Zane        | Setting         | 3                       | 92.67%             | Setting           | 3                       | 78.00%             |
| Cory        | *               |                         |                    | *                 |                         |                    |
| Zander      | Setting         | 3                       | 92.67%             | Setting           | 3                       | 100.00%            |
| Nancy       | Person          | 1                       | 67.00%             | Person            | 3                       | 81.67%             |

Notes. \* = Indicates generalization probes were not conducted.

demonstrated excellent joint attention with another adult during the first generalization probe. She did not meet the criterion for the following two sessions, which may have been related to competing behaviors that Nancy engaged in during those final sessions.

Overall, the current study found evidence of preliminary support for animated VM as an efficacious treatment in promoting acquisition of joint attention and social engagement skills. Several implications are noted as to why animated VM led to rapid acquisition of skills for most of these children in the study. One, watching videos, especially animation videos, may be a reinforcing activity for children with ASD. In addition to using all animation in the treatment videos, the current study also developed the models in the videos based on the characteristics of real-life models (i.e., the participant and adult model). Together, the use of animation and incorporation of a specific child model who possessed the physical characteristics of the individual participant may have motivated each of the participants to attend to the video and thus, lead to an increased likelihood that the participants learned or imitated the modeled activity (Bandura, 1977) in the videos.

Furthermore, the use of VM is the focus of the videos on the participants' attention to relevant cues (McCoy & Hermansen, 2007). The current study assessed each participant's preferences and embedded these in the context of the video and as reinforcers for achieving target responses during play sessions. By strengthening the response-reinforcer relationship and highlighting the relevant cues, the method used in the current study may have helped the participants to focus on the important information and as a result, rapid acquisition of the target skills was observed.

Additionally, animated VM may be a more efficient intervention for wide implementation across various settings (e.g., schools, clinics, and homes) than traditional VM. Recent innovations in technology have greatly simplified the procedures by which videos are designed and developed. For the current study, animation videos were developed through a simple online program (i.e., <http://www.goanimate.com>). The main purpose of the program was to allow individuals with no background in animation to quickly and easily create animated videos with simple steps as such as click, drag, and drop. Although basic technology and online navigation knowledge is still needed, the program does not require technical knowledge related to video creation, specialized equipment, or software as in traditional VM.

Several other advantages to using animation and the online programs were also noted. In particular, no live persons were needed, which may address the important issue of anonymity when using traditional VM with peers or adults as models. Using animation may also solve the difficulty in finding models for the videos, which has sometimes been noted in the literature (e.g., Bellini & McConnell,

2010). An additional limitation of traditional VM is it requires an extensive amount of time and effort for the development of the video, making the intervention less feasible to implement, which can deter stakeholders from using the intervention. The range of time to develop the animated videos for the present study using the online program was between 20–30 min for each video. Thus, in contrast, animated VM can shorten the required time to create a video, consequently leading to a more efficient process and intervention that can be feasible for many individuals in the school or home setting.

These outcomes add to the continually growing body of literature implicating video-based interventions as an effective intervention for children with ASD that leads more pro-social behavior. That is not to say concerns with screen-based technology for children with ASD are not warranted (e.g., Healy et al., 2017); however, when the technology is actually applied in a purposeful and targeted fashion, such as AVM, the affinity for the screen seems translate into pro-social skill acquisition and increased engagement with the real world.

#### 4.1. Limitations

Although findings from the present study provide preliminary evidence of the efficacy of animated VM and important implications for VM interventions, there are several limitations that should be taken into account when considering the results. First, is the concern of learning effects that may have occurred during baseline independent of the animated VM treatment. It is likely that the established baseline procedure may have contributed to some form of learning. Specifically, if the participant exhibited a target response(s) when presented with the discriminative stimulus (e.g., a locked container with a preferred toy inside), the play partner reciprocated with a similar appropriate response(s). For those who remained in baseline extensively, anecdotal evidence (e.g., in-vivo observation during sessions) suggests some learning effects may have occurred as a result of tangible reinforcement and social praise when target responses were demonstrated. It is unclear how much of the learning effects confounded the independent variable. However, it should be noted that quantitative data using visual analysis clearly showed a rapid increase in level and trend when animated VM was implemented for participants, indicating a distinction in data between baseline and treatment. In the future, great consideration should be taken regarding the length of participant baseline data, particularly for those who have disproportionately may have baseline conditions based on the criteria used here.

Treatment procedures, as adapted from the Charlop et al. (2010) study, established that if the participant met the performance criterion, treatment data were no longer collected and generalizations probes were then conducted. With exception of Cory, who did not meet performance criterion at all for both target skills, and Brandon, who needed four treatment sessions to meet criterion for joint attention, all other participants achieved criterion within the first two sessions. Thus, with both target skills for most participants, treatment phases contain only two data points. Although subsequent generalization probes were also conducted for those who met performance criterion, limited treatment data points were somewhat concerning in that it cannot be established with utmost confidence that treatment maintenance was truly established.

Additional concerns were also noted with regard to generalization and follow-up sessions. Although most the participants demonstrated generalization of the target behaviors across setting and person, peer probes (i.e., generalization probes with peers) were not conducted. Also, the study did not evaluate if VM also increased the target behaviors in other situations (i.e., different discriminative stimuli that were not taught in video and presented during play sessions). Further, no follow-up data were collected after generalization so it is uncertain if the target behaviors would be maintained over time.

In addition to threats of internal validity, several threats to external validity were also noted. First, the number, age, and gender of participants for the present study were restricted; thus, it cannot be firmly established that the efficacy of animated VM can be broadly recommended to those outside of the current group. Although there was one girl in the study, more confidence would be established for broad recommendations if the gender ratio had been more balanced. Further, the present sample consists of primarily Caucasian children, which does not reflect the ethnic composition of the US and this should be considered when making generalized findings to the broader population. With regards to children with ASD, findings were only limited to those within this population as every participant in the study had a primary diagnosis of ASD. That being said, while ASD diagnoses were confirmed via medical history, an independent assessment was not done as part of the procedures. Finally, findings were limited only two target, specific social skills. Thus, it is unknown if similar findings will be found with other social skills, adaptive skills, or even with use to reduce disruptive behavior problems.

#### 4.2. Future directions for research

Although findings provide preliminary support for the efficacy of animated VM, further investigation is needed to establish its effectiveness and contribute to VM as an evidence-based treatment for social skills. Broadly, future studies should involve randomized clinical trials replicated with larger number of participants including those with various diagnoses (e.g., ODD, anxiety, depression, etc.), with a wider age range, with individuals having a more balanced gender ratio, and to examine other social and adaptive skills. The effectiveness of animated VM to reduce problem behaviors should also be explored. Such replications would yield more significant data to support the effectiveness of animated VM as treatment approach that can be widely recommended.

In addition, findings from the present study suggest that pre-requisite assessments are an important consideration that may assist in predicting whether VM is an appropriate, beneficial intervention. Pre-participation assessments of the current study evaluated two important skills that have been suggested to be important for acquisition: attention ability and imitation repertoires. Future studies should examine these skills as well as the presence or absence of disruptive problem behaviors. As in the case of Cory, who did not respond well to the intervention, problem behaviors were prevalent throughout intervention sessions and may have affected the

acquisition of the target skills. Identification of behavior problem will inform decision as to whether or not the participant should be benefited more from behavior intervention, social skills intervention, or a combination of both.

It is widely accepted that comparison studies inform decisions regarding the selection of the most appropriate treatment for each individual or group of individuals. As such, further research should examine the effectiveness of animated VM relative to other types of VM that are explored within intervention literature. Moreover, feasibility is major determinant of treatment acceptance and implementation across various settings. Findings from the present study suggest that animated VM may be more time efficient and cost effective than traditional VM interventions. In addition to effectiveness evaluation, future studies should also strive to empirically compare the efficiency of animated VM to the traditional VM types, which have shown to be effective but limited in efficiency.

Finally, generalization was not extensively evaluated within the present study. Generalization probes were only conducted with a different adult and in a different clinic room. The obtained results from probes cannot necessarily be extended to conditions that are more disparate from the treatment setting (e.g., interaction with peers during social situations at school). Also, follow-up probes were not conducted. Collectively, future research should include more extensive measure of generalization and maintenance of acquired skills to provide further evidence regarding the effectiveness of animated VM.

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