THE EFFECTIVENESS OF VIDEO MODELING TO TEACH GROSS MOTOR PLAY SEQUENCES TO CHILDREN WITH AUTISM SPECTRUM DISORDER

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ABSTRACT

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The motor development of preschool-age children with autism spectrum disorder (ASD) has received increased interest among researchers, as evidence of gross motor deficits and atypical behavior for this group emerges (Lloyd, M., Macdonald, M., & Lord, C. (2011). There is extensive research demonstrating the benefits that video modeling provides for children with ASD. The present study examined the effectiveness of video modeling on the acquisition of chained gross motor play sequences for children diagnosed with ASD. Four children were taught to functionally engage with an obstacle course that involved a complex chained sequence of behaviors. Three out of four of the participants acquired the modeled behaviors. These results provide empirical evidence that support the effectiveness of using video modeling as an approach to teach gross motor play activities.

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Introduction

The development of gross motor skills is an essential building blocks for promoting complex motor abilities and allowing individuals to connect and interact with the world around them (Bedford, R., Pickles, A., & Lord, C., 2015). Early motor milestones can be key indicators of social-cognitive functioning and can influence language development and motor performance (Liu, T., Hamilton, M., Davis, L., & ElGarhy, 2014).). Therefore, it is essential for children to be exposed to opportunities to develop motor skills, as doing so has a fundamental influence on multiple developmental domains (Zeng, N., Ayyub, M., Sun, H., Wen, X., Xiang, P., & Gao, Z., 2017). Autism spectrum disorder (ASD) is a disability that is often associated with deficits in motor and cognitive development (Rafie, F., Shikh, M., Jalali, S., & Pourranjbar, M., 2015). Although motor deficits are not a core characteristic within the ASD diagnostic criteria (American Psychological Association, 2013), many studies have suggested that motor delays are common for children with an ASD diagnosis (Ming, X., Brimacombe, M., & Wagner, G. C., 2007). ASD is also associated with engagement in restricted patterns of stereotypical and repetitive behaviors (Watt, N., Wetherby, A. M., Barber, A., & Morgan, L., 2008). All of these factors may limit opportunities for individuals with ASD to engage in gross motor and physical activities in a manner similar to their typically developing peers.

The preschool years are characterized by significant changes in the acquisition of children's locomotor and gross motor performance (Williams, H. G., Pfeiffer, K. A., Oneill, J. R., Dowda, M., Mciver, K. L., Brown, W.H., & Pate, R. R., 2008). Gross motor skills and movements should therefore be a part of early intervention for children with ASD. The potentially useful effects of gross motor engagement may provide opportunities for peer integration, motor planning and facilitation of language development for children with ASD (Yanardag, Akmanoglu, & Yilmaz, 2013).

Veldman, Jones, & Okely (2016) conducted a literature review to determine the efficacy of gross motor development interventions for typically developing children. Based on a search across six electronic databases, during the years 2011 and 2014, the researchers identified seven studies, with six that found statistically significant results for interventions targeting gross motor skills. The researchers noted that the studies did not sufficiently describe components of the interventions, which interferes with interpreting results and making recommendations for practitioners. In general, despite the significant need for early intervention targeting gross motor development, there is a paucity of research in this area for young children, and almost no high-quality intervention research specific to children with ASD. This limitation in the ASD intervention literature creates challenges for caregivers and practitioners looking to teach gross motor play skills to children with ASD.

Duquette, Carbonneau, Roult, & Crevier (2016) describe several barriers that children with ASD face when it comes to involvement in gross motor play activities. First, the activity itself can cause an issue because it is difficult for children with ASD to overcome the barriers associated with understanding how to manipulate specific play materials, remembering the sequences of movement associated with a game or activity, and recalling the rules involved. Second, because of some of these deficits, negative responses from peers becomes a social barrier for inclusion in gross motor play activities. Third, adults who are in positions to arrange positive social environments during gross motor activities (e.g., teachers, coaches) often don't know how to do so in an inclusive manner for children with ASD. These barriers may perpetuate a cycle of exclusion of children with ASD in group and team related activities. Effective treatment for children with ASD should therefore incorporate gross motor play activities that are likely to occur when children interact with typically developing peers (e.g., playgrounds, obstacle courses, sports).

One approach that has been extensively used for teaching new skills to children with ASD is video modeling. Video modeling is an intervention technique that incorporates a visual model of an individual engaging in a target behavior prior to the participant's opportunity to engage in the response (Bellini & Akullian, 2007). This method has resulted in increased independent responses for relatively long chained sequences of behaviors without providing prompts or instructor feedback (D'Ateno, Mangiapanello, & Taylor, 2003).

There are several benefits of using video modeling for skill acquisition among children with ASD. First, videos can be edited in such a way that any excess environmental distractions can be omitted, and the target behavior and specific environmental stimuli can be emphasized (Bellini, et al., 2007). Second, many individuals with ASD demonstrate an interest in technology, making video modeling potentially more appealing than other methods of instruction (Charlop-Christy, Le, & Freeman, 2000). Finally, consequences of a behavior can be embedded into video models, which might signal to observers that similar consequences may be available if the observer performs a similar behavior (Plavnick, J. B., Hume, K. A., 2013).

D'Ateno and colleagues evaluated the effects of video modeling alone on the acquisition of motor and verbal play sequences for a 3-year-old girl with autism. Although not applied to physical gross motor behavior associated with sport or play activities, video modeling was effective for teaching chained sequences of motor behaviors, as would be necessary in physical play scenarios. During intervention sessions, the participant viewed the video model and was then provided with a minimum delay of an hour before being presented with the play materials. Three complex play sequences were taught with no additional prompts or reinforcement contingencies provided. The participant obtained the majority of modeled motor and vocal responses. Overall, the study resulted in an increase in both verbal and motor play responses for all three play sequences. It is important to note that it took fewer sessions for the participant to reach mastery criterion for each additional sequence that she was exposed to. This study extended the current literature and provided important implications on the effectiveness of video modeling as it relates to more complex sequences. The play sequences in the study were relatively long and did not require the use of reinforcement contingencies or experimenter prompts, removing components often incorporated into behavioral interventions. Furthermore, the study suggests that once the general concept of video modeling is trained, children with ASD might learn additional complex sequences at an increased rate, without the use of additional prompt and fading hierarchies.

Yarnardag and colleagues (2013) conducted one of the only known studies to apply video modeling to teach gross motor fitness skills to children with ASD. The researchers taught aquatic play skills to three children with ASD using a multiple probe across behaviors design, replicated across participants. Baseline sessions indicated that the number of correct responses for the participants was 0% across each session. The results of the intervention sessions indicated that all three of the participants demonstrated 100% correct responding by the second teaching session. Notably, each participant demonstrated very few incorrect responses during probe sessions when video models were removed, and no incorrect responses during intervention phases. Additionally, all participants gained new skills to engage functionally in aquatic activities, which provided more opportunities for social integration and enhancements in motor skills (Yarnardag et al., 2013). These outcomes support several studies suggesting video modeling may be an efficient instructional approach (D'Ateno et al., 2003, Plavnick & Vitale, 2015). Yarnardag and colleagues extended video modeling research by successfully applying the intervention to skills related to exercise and motor performance. However, it was a single study with three participants, focused on teaching basic aquatic skills rather than a more complex sequences of behaviors.

Gross motor skill development is important for participation in many social learning activities as children get older, including group games and team sports. Many children with ASD demonstrate deficits in gross motor play skills and might therefore miss out on participating in activities that require complex chains of gross motor behavior. In previous literature, investigators have demonstrated the efficacy of video modeling on skill acquisition but have not explicitly demonstrated the effects on complex sequences of gross motor skills. Therefore, the purpose of the current study is to assess the effects of video modeling on the acquisition of complex chained gross motor behaviors by children diagnosed with ASD.

Methods

Participants

Four children ranging from age three to four were participants in the current study. All of the children attended therapy at an early intensive behavioral intervention (EIBI) center for 30 hours a week where they received one-on-one treatment. Behavior analysts at each site were asked to refer children that did not engage in play materials functionally during recess and free play. Participants were selected based on the following criteria: a) A diagnosis of ASD according to a comprehensive diagnostic evaluation; b) engagement in generalized imitation and the ability to follow two-step instructions when assessed by researchers, c) displayed developmentally appropriate gross motor milestones such as jumping, crawling, and balancing on one foot for 3 seconds (Dosman, C. F., Andrews, D., & Goulden, K. J., 2012); d) observed to attend to a 25 second video model, and e) could imitate a three-step video model (e.g. pick up ball, place in hoop, thumbs up). All developmental skills were confirmed through observation of the participants during treatment sessions.

Molly was a 4-year-old girl who often engaged in repetitive stereotypical behaviors, such as skipping and arm flapping, during free play and one-to-one instructional time. Molly was observed to be dependent on physical prompts, which increases the time it takes her to learn new skills as reported by her behavior analyst. She displayed minimal play skills during free play, unless instructed and prompted by an adult, and generally engaged in skipping back and forth, or hopping in place, while scripting repetitive non-functional vocalizations. Her behavior analyst reported that she had generalized gross motor imitation skills, meaning that she could imitate various age-appropriate motor movements during play, with objects, and in various settings.

Lee was a 4-year-old boy who exhibited some engagement with play structures during recess, but generally only when accompanied by an adult. Based on report from his behavior analyst, he mostly engaged in stereotypy in the form of hand licking and skipping around the playground. He also engaged in behaviors that resulted in getting the attention of the staff, such running up to a staff member, smiling, then running away. His site behavior analyst determined that he has generalized one, two, and three step motor imitation skills across a variety of settings and with objects. He is a also a student that generally needs a potent reinforcer, when learning new skills.

Oscar was a 4-year-old boy who engaged in functional, though repetitive play for the entire recess period. For example, he would run back and forth across the gym pushing a toy car repetitively and only stop for social engagement, generally commenting about what he was doing (e.g., “Look, its going fast!”). Oscar was a student that generally requires very few learning trials to learn a new skill and is often prescribed least-to-most prompting during teaching. He has been observed to appropriately script lines during play from videos that he has previously seen on YouTube, as a form of engagement with peers.

Brian was a 4-year old boy who was recommended by his behavior analyst because he engaged in almost no functional play during free play in the classroom and recess time unless accompanied and prompted by an adult. Brian engaged in high rates of stereotypical behavior, which included hand flapping, peering, and repetitively running back and forth. He generally resisted adult’s attempts to teach functional play, often pulling away when being prompted through physical activities, such as putting a basketball in a hoop or playing ring-around-the-rosie. Brian exhibited generalized imitation skills in a variety of settings and during play with objects. He is also a student that displays prompt dependency when learning new skills.

Settings and Materials

All sessions were conducted across three EIBI centers, each housed within a private or public preschool. Research sessions were conducted in a room or office, separate from the EIBI classroom setting. The only materials included in the session were items necessary for the obstacle course, and an iPad used to show the video model. All other items in the room were pushed to the side or stored away from the course. Only the participant, behavior technician, and a data collector were in the room for all baseline and intervention sessions.

The materials required for the obstacle course included three carpet circles, balance stepping buckets, a hula hoop, a hula hoop stand, a recordable button that played pre-recorded messages when pressed, three ring toss rings, a 4-inch binder, a small chair, and a ring stacker pole. These materials were chosen because they could be used to create an indoor course in varied settings. Additional materials included a pen and an obstacle course task analysis data sheet to record participant responses.

All materials were set up in a sequential order. The balance bucket stepping stones were lined up, but rather than being in a straight line, they curved to ensure that the participant would follow the path of the video model rather than walking straight across the buckets. Following the stepping buckets, three carpet squares were placed approximately 15 cm apart from each other in a straight line. Then, the upright hula hoop was placed next in the sequence, being propped up on the inside of the rings of a 10 cm binder so that it stood vertically. Next, the ring stacker was placed on a chair, with four rings placed on the floor in front of it. Finally, the recordable button was place on a table at the end of the course.

The obstacle course video model was recorded and presented on an iPad for a total duration of 30 s. All videos displayed an adult completing the obstacle course with the same behaviors. During the videotaped play sequence, the model was positioned at the beginning of the course and given the direction, “Go do the obstacle course”. She is seen placing both feet on the first bucket, each subsequent step the model placed one foot on the next bucket, then brought both feet together onto the same bucket. The model then stepped down from the stepping buckets and hopped with two feet across the three carpet circles. Next, she went through a hula hoop that was designed to stand vertically, allowing the model to crawl on hands and knees. She then stood up and walked over to the ring stacker and picked up and placed each ring, one-by-one onto the pole. Finally, she pressed the electronic button that emitted one of four various praises (e.g., “Yes!”, “Woohoo!”), signaling the completion of the course.

Dependent Variable

The dependent measure was the percentage of correct independent steps completed in the obstacle course sequence. A task analysis was developed to measure performance on each step of the obstacle course, with a total of 27 possible steps. To be scored as correct, a response had to be performed in the order of the steps described in the task analysis. The absence of a response for 30 s or more following the previous S^D was scored as incorrect. The S^D for the first step was the phrase, “Go do the obstacle course.” For all the subsequent steps the S^D was the completion of the previous skill. The overall percentage of correct responses was calculated by dividing the number of correct responses by the total number of steps in the task analysis, multiplied by 100. All sessions were video recorded. Data were collected by the primary researcher from the video recording following the completion of the session.

Interobserver Agreement

Two secondary observers independently scored 30% of all sessions, evenly distributed across participants and conditions, to establish interobserver agreement (IOA). The primary researcher trained two graduate level researchers to code data based on the operational definitions of each behavior in the course. Once all three observers met 90% of above agreements during the training sessions, each observer was assigned videos to code for IOA. Videos were chosen by using an online random number generator. Agreements were scored if items on the task analysis were coded the same by both observers. Disagreements were scored if one observer scored an item as occurring while the other observer scored it as not occurring. Percentage of agreement was calculated by dividing the number of agreements by the sum of agreements plus disagreements and multiplying by 100. IOA for Molly was consistently 96% for both pre-intervention and intervention conditions. IOA for Lee was calculated as 85% during all pre-intervention sessions and 89% during intervention sessions with a range between 86% and 92%. IOA for Oscar was 95.5 % during pre-intervention sessions with a range of 93% to 96% and consistently 100% during intervention sessions. IOA for Brian was calculated reliably as 96% during both pre-intervention and video model intervention sessions.

Experimental Design

A multiple probe across participants design was used to assess the effects of video modeling on the acquisition of chained gross motor play skills. This approach involved sequentially implementing the intervention with participants in a systematic manner (Gast & Ledford, 2014). Five probe sessions were conducted for all participants to serve as an assessment of performance before a participant was introduced to a teaching session. The first participant was then introduced to the video modeling intervention. The criteria for introducing subsequent participants to the intervention phase required that the previous participant demonstrated at least three sessions above pre-intervention probe levels. Before each new participant was introduced to teaching sessions, all participants were re-introduced to probe sessions without the video model to assess for changes in performance and to evaluate if video prompts could be removed. This sequence continued until all participants transitioned to intervention and met predetermined mastery criteria of 80% accurate performance across three consecutive sessions.

Procedures

Probe sessions. Participants were taken into a room with the obstacle course already set up. The researcher physically guided participants to the beginning of the course and started probe sessions by telling the participant to “Go do the obstacle course". Participants had one opportunity to engage with the course for each session. Materials for the obstacle course were placed in order of the sequence described above in the teaching materials section for all probe sessions. Data was recorded as a + if the participant engaged in the behaviors correctly according to the operational definitions described in *Table 1*. Any other responses or behaviors in the incorrect order were marked as a -. No response or NR was recorded if the participant did not engage in behaviors within 30 s from beginning of the session. Probe sessions were terminated after 30 s of inappropriate use of materials, performing behaviors other than engagement in the course, no responses, or if a participant attempted sequences in the incorrect order. For example, a participant attempting to hop across the carpet circles before attempting the stepping buckets was marked as an error. Inappropriate use of materials was defined as using materials in ways other than indicated on the task analysis or engaging with materials out of the order of the task analysis. A total of five probe sessions were conducted before participants were introduced to the intervention. Subsequent probes were conducted for all participants anytime a participant who had transitioned to intervention met the performance criterion of three consecutive sessions above that participant’s pre-intervention probe levels.

Intervention. Intervention sessions were identical to probe sessions except that the researcher showed participants the video model prior to the participant completing the course The participant viewed the video model while standing at the beginning of the obstacle course. The researcher directed the participant's attention to the video model and said, "Let's watch a video". If the participant was observed looking away from the video model for more than 2 s, the video was terminated, the researcher said, "Let's watch it again", and replayed the video from the beginning. This correction sequence was repeated as needed until the participant was observed to look at the video for the entire duration. The researcher removed the iPad when the video model was complete and said, "Go do the obstacle course". The participant was then given the opportunity to perform the obstacle course. No additional prompts were provided. Sessions were held three times a day, twice a week until mastery criterion was reached. Sessions occurring on the same day were each a minimum of 15 min apart. Criterion for mastery was a performance of 80% or above of independent correct responding for three consecutive sessions. Follow-up probes were conducted for each participant after they met criterion for mastery. These probe sessions were identical to pre-intervention sessions.

Added components for Brian. Brian displayed a unique pattern of responding in which he was not able to accurately complete the obstacle course even after a variety of phase changes were incorporated to provide additional support. During pre-intervention probe sessions. Upon introduction to video modeling sessions, researchers implemented the same procedures that were used for all other participants. During the first phase change video chaining was introduce. Brian was shown one set of behaviors for an obstacle in the sequence then given the opportunity to engage in the course. A new portion was introduced after three sessions of the previous obstacle. For example, for three sessions Brian would be shown the video model of just the stepping buckets, then was given the opportunity to engage with the course. Then on the next day of intervention, he would view the behaviors on the stepping buckets and the carpet circles, then be given the opportunity to engage with the materials. This would continue until Brian had been shown the behaviors for the entire obstacle course. However, when this was not successful, researchers implemented video prompting. In this teaching procedure the researcher would display the first section of the video, pause it, then let the student engage with that section of the course. Brian would then be shown the second part of the course, have the opportunity to engage with that section, and be paused for the next viewing. This would be continued until all sequences in the course were viewed and he was given the opportunity to engage with the materials. Following this, another phase change was conducted incorporating physical prompts using graduated guidance. During this phase researchers used physical prompts only and did not incorporate the video model. Finally, the researchers conducted a phase change of light physical guidance to help support in the case that it was just a motor planning issue.

Procedural Integrity

Procedural integrity (PI) was calculated by a secondary observer for 30% of baseline and intervention sessions for each participant. This checklist of steps necessary to complete a session was provided to the secondary researcher who collected PI on the researcher's performance while sessions occurred. PI met 100% accuracy, based on the checklist, for all of the sessions that were observed.

Data Analysis

Visual analysis was used to assess for a functional relation between video modeling and the performance of chained gross motor play skills. This approach of graphic display during the intervention supports ongoing evaluation of behavior change for all of the participants (Wolery

& Harris, 1982). The individualized method allowed for systematic modifications based on observed data and trends (Gast, 2015). Upon introduction of the procedures, the changes in level and trend were assessed for each participant to determine the effectiveness of video modeling. Additionally, replication of effects of the procedures was used to evaluate the internal validity. For this reason, visual analysis is the most efficient method for analyzing the data.

Results

Figure 1 depicts the percentage of steps completed correctly on the obstacle course task analysis for each participant during pre-intervention and intervention sessions. Molly initially scored 27% then decreased to less than 10% correct responding for all remaining pre-intervention probe sessions. Upon entering intervention, her performance increased to 93% in the first session, then to 85% for the following two sessions, reaching mastery criterion following her performance after the third observation of the video model. During follow-up, which occurred two weeks later due to snow days and participant illnesses, performance levels initially dropped to 44%. Researchers conducted additional follow-up sessions to determine whether additional training may be needed. Her performance reached mastery criterion in the second and third follow-up probe. Therefore, the obstacle course sequence was considered 'mastered' and no additional training was provided.

Lee displayed an initial increasing trend from 35% to 46%, then a decreasing trend down to 27% during pre-intervention probes. He participated in a total of eight pre-intervention probe sessions before entering intervention. During his first three intervention sessions, his performance increased to 67%, 70%, and 69%, respectively. When all participants were reintroduced to probe sessions, his responding maintained at a similar level with scores of 62%, 58%, and 67%. When video modeling was reinstated, he scored 85%, 81%, and 85%, reaching mastery criterion on the second day of video modeling exposure. Researchers conducted a follow-up probe two days after Lee reached mastery criterion and he remained at 80% correct responding.

Oscar scored 0% to 3% during pre-intervention probe sessions. Upon introduction to the intervention, his initial performance remained at 3%, but by the second session he scored 85%.

For the following four sessions he scored 100%, reaching mastery criterion for the obstacle course by his fourth intervention session. During his follow-up probe he scored 96%.

During pre-intervention probe sessions, Brian consistently displayed 0% responding, and almost no interaction with the obstacle course materials. He engaged in high rates of stereotypical behaviors, including running back and forth and arm flapping. Upon introduction to video modeling sessions, accurate responding remained around 0% for six sessions before researchers decided to implement the first phase change. During video chaining sessions Brian displayed variable results ranging from 0% to 62% and this was discontinued after 13 sessions. When introduced to the physical prompts using graduated guidance, his results ranged from 0% to 64% and were significantly variable. During only physical prompting with graduated guidance phases, the results ranged from 0% to 69%. Finally, the researchers conducted a phase change of light physical guidance. His performance decreased to a range of 0% to 64%, displaying significant variability. Researchers terminated sessions with Brian after a total of 36 sessions.

Discussion

The main purpose of the study was to evaluate the effects of video modeling on the acquisition of a complex sequence of chained gross motor play behaviors. The findings of the study were that three out of the four participants acquired the skills to complete the obstacle course within six sessions or fewer after exposure to video modelling and of these participants, all of them maintained the skill during follow-up probes. These results indicate a functional relation between video modeling and the participants' performance in completing a chain of gross motor play skills. Additionally, three of the participants were able to independently complete the chain after the video model was removed.

The results of this current study offer valuable contributions to the existing literature (D'Ateno et al., 2003, Yanardag et al., 2013). Video modeling as a teaching procedure can promote a rapid rate of acquisition for the targeted skills. Similar to Yanardag and colleagues, in the current study, two of the four participants demonstrated an immediate increase in correct responding following exposure to the video model. Molly and Oscar reached 80% accurate responding by their second intervention sessions. Lee reached mastery on his fourth intervention session. Importantly, participants imitated the video models and thereby learned to perform the obstacle course in the correct order with no additional prompts provided by the experimenter. This was an important finding as it speaks to the pace at which stimulus control can be transferred to the events in the natural environment that should control responding (e.g., the obstacle course, an instruction to complete the course) when video modeling is used as opposed to other types of prompts. Prompt dependency is a common problem for children with ASD (Jones & Zarcone, 2014), and had been observed to be a barrier to learning for Molly. Nevertheless, she quickly learned from video modeling alone and performed the obstacle course at a consistently high level after only three video viewing sessions. Video modeling as a teaching procedure may eliminate the need for additional physical prompts that can be difficult to remove.

It is also noteworthy that participants repeatedly completed the obstacle course despite the absence of contrived reinforcers following completion of the course. These results suggest that, although contrived reinforcement contingencies were not included in the intervention, participants may have accessed some form of reinforcement simply by engaging in the obstacle course in a manner similar to what they had observed in the video. The results of the current study support D'Ateno and colleagues (2003) investigation of complex play sequences without error correction procedures or reinforcement, as three out of four participants successfully completed the course without additional prompts, reinforcement, or feedback. Unfortunately, we cannot be certain why some children with ASD imitate video models without additional reinforcement. One hypothesis is that completing the obstacle course was a preferred activity for participants and they accessed reinforcement by completing tasks within the course. However, the fact that the majority of the children completed the course in the same order observed in the video suggests there may be some reinforcing value of matching the behavior observed in the video.

Individual participant patterns of responding provide several important implications regarding video modeling as an instructional tool. During intervention session two for Molly, rather than hopping across each carpet circle one at a time, she repeatedly hopped across the circles, missing each carpet circle several times before completing this sequence of the course (i.e., hopped eight times across the circles when there were only three circles to hop across). These were recorded as errors based on the operational definitions found in *table 1.* It was important for researchers to refer to these definitions when coding behaviors not only for reliability with recording data, but also to ensure that individual responses were consistent with the material's intended use. This is an important part of participation in games and play activities involving other children. Children with ASD often struggle to follow the intended rules of a complex game or play sequence, making it difficult to understand how to engage in play activities and which can lead to negative responses from peers (Duquette, et al., 2016). Many play activities that children engage in involve multiple complex components, much like an obstacle course. Finding instructional methods to teach these play skills accurately may help practitioners ameliorate some of these social barriers that children with ASD may encounter.

Molly displayed a dip in percentage of correct responding during her first follow up probe session. She attempted to finish the course after the experimenter terminated the session, due to lack of responding. Therefore, performance may have been low due to lack of sufficient time allotted to finish the course rather than the lack of ability to complete it accurately. Her attempt to complete the course after the session was terminated suggests that there may have been natural reinforcement contingencies in effect for the completion of the course. This may also be why in the following session there was an immediate increase in performance without additional training. Once she contacted the contingency of not completing the obstacle course in the designated time frame, she may have learned to complete the course immediately in order to finish all obstacles in the course. Molly's results yielded important implications that video modeling can produce natural reinforcing contingencies by exposing children with ASD to new ways of engaging in activities.

Lee demonstrated an increasing trend in responding as he was exposed to video modeling conditions. He was reintroduced to probe sessions without the video model, following three successive sessions above baseline levels, as indicated in the experimental methodology prior to introducing a new participant (i.e., Oscar) to the intervention. However, because Lee had not yet met mastery criterion for the obstacle course, an additional phase of video modeling was introduced following the probes. During his second day of exposure to the video model, Lee reached mastery criterion. Unlike Molly and Oscar, it was more of a gradual increase rather than an immediate increase to mastery level. The common errors that Lee made during each session were on the stepping buckets at the beginning of the course. This may be due to his attending to behavior that he was expected to engage in (i.e., walking across the buckets) but not necessarily the order in which to do so, resulting in a more gradual change in correct responding. Video modeling as a teaching technique may have been more efficient for Lee if he had more opportunities to view the model before performing the task. This provides important implications for researchers using this technique that demonstrate that some children may need more observations than others for video modeling to be more effective.

Oscar demonstrated the most rapid and accurate responding upon introduction to intervention. During baseline sessions he did not engage in the course, but instead stood at the start of the course looking at the experimenter. One possible explanation for him looking to the experimenter is that he may have been seeking further direction for how to engage with the course. Therefore, when provided with the video model he demonstrated an immediate increase in accurate responding. These results indicate that video modeling did not necessarily teach the motor skills, instead they were already present in his repertoire, but rather taught the sequence of behaviors and how to interact with the materials.

Motor planning activities and organized sports are often difficult for students with ASD because they may lack the social skills to follow activity-specific rules, which can result in reduced participation (Menear & Smith, 2008; Obrusnikova & Dillon, 2011; Ohrberg, 2013).

The delay in responding that Oscar displayed until provided with further instruction demonstrates how video modeling can be useful as a rule following instructional method. Meaning, for early childhood games with a complex sequence of behaviors such as T-ball, hopscotch, or other duck duck goose, video modeling may be an appropriate technique for teaching the steps necessary to complete the activity. Teaching children with ASD the proper topography for engaging with new materials may help them shift from not engaging with materials at all to performing with accuracy and potentially finding the activity reinforcing as well.

There are several limitations of the present investigation that could be examined with future research. One potential limitation of the study was that the rapid acquisition of the skill may result in few observations of the video model and could potentially interfere with sustained performance. Although during follow-up sessions Molly, Lee, and Oscar still displayed performance levels above mastery criterion, this may not have been the case if more follow-up sessions were conducted on a later date. Future research could assess the extent to which video modeling promotes sustained performance over a prolonged period of time.

Another limitation of the study was that video modeling was not effective for Brian. He went through a series of phase changes as displayed in *Figure 1,* which included physical prompts using graduated guidance, video prompting, video chaining, and minimal physical guidance. Of all of the approaches that were tested, none of them were effective in teaching him the sequence. There are cases of poor outcomes with video modeling, but they are the exception in prior video modeling studies (Ogletree & Fischer, 1995; Thiemann and Goldstein, 2001; Hagiwara and Myles, 1999). During Brian's first video chaining session, although he was only presented with the first sequence in the video model, he completed more than half of the obstacle course, indicating to researchers that poor performance may have been a lack of motivation rather than an insufficiency of training. At the time, researchers made the decision to exhaust all video modeling techniques before incorporating additional prompting or reinforcement methods. For future sessions with Brian, a reinforcement component would be appropriate to implement to assess for changes in performance. Additionally, none of the five intervention approaches were effective for Brian to reach mastery level responding for the obstacle course, leading researchers to believe that there were additional prerequisite skills that Brian was lacking. However, when prerequisite skills were re-assessed in isolation (e.g., hopping, balancing on one foot, imitating three-step videos), Brian responded accurately without the use of reinforcement. To get a better understanding of the support that Brian needed, further investigation is necessary to assess whether breaking down the obstacle course components into shorter sequences and adding reinforcement for these broken-down steps would be an effective approach for him. Future research should examine characteristics of children who are most likely to benefit from video modeling to better understand when, and when not to use it as an intervention.

Overall, the findings of the current investigation indicate that video modeling is an effective and efficient approach for teaching complex gross motor play sequences to children with ASD. Video modeling as an approach may be more desirable than other teaching methods for some clients because of the rapid rate of acquisition associated with this method and ease of implementation without additional prompts or reinforcement contingencies. Additionally, there is some indication that completion of the course may have served as a natural reinforcement contingency. Therefore, video modeling as a teaching technique can potentially expose children with ASD to new ways of engaging in activities in ways that they may enjoy. Moreover, the study also explored how video modeling can be used as a rule teaching method to teach children with ASD how to engage in complex sequences of gross motor play activities.

APPENDIX

Obstacle Course Video Model Protocol	
Therapist video modeling instructions: Position the student at the beginning of the obstacle course. Provide video model for participant. After the participant views the model, provide the SD, "Go do the obstacle course."	**Error Correction Procedures:** If participant does not attend to video model for more than 2 seconds, replay model and provide the SD, "Let's watch it again" **Probe sessions:** Terminate session after 30s of errors in responding **Intervention sessions:** Terminate sessions after 30 seconds of error, or no response.

Target Behavior:	Description:	Error:	Non-error:
Walks across balance stepping buckets	Student places both feet on one buckets, student steps with one foot on subsequent bucket, then places second foot on the secondary bucket in this sequence.	*Student stays on the same bucket for more than 5s* *Student steps off buckets and does not attempt to get back on* *Student deviates from course* *Student walks across buckets out of the sequence in the model*	*Student loses balance/ misplaces footing and falls of bucket and attempts to get back on within 5s*
Hops on across carpet circles	Student hops with two feet on each carpet circle. <u>Student must leave the ground with both feet simultaneously but</u> can land with one foot at a time.	*Student walks across carpet circles* *Both feet miss carpet circle after hopping* *Student deviates from carpet circles* *Student completes this step before completed prior steps in task analysis*	*Student lands on carpet circle with one foot at a time* *Student misses one foot or partially misses the carpet circle* *Student hops directly off buckets onto carpet circles*
Student goes through hula hoop	Student will crawl through or climb through the inner circle of the hula hoop.	*Student walks around hula hoop* *Student deviates from obstacle course* *Student completes this step before completed prior steps in task analysis*	*Student gets stuck going through hula hoop* *Student steps through hula hoop one foot at a time* *Hula hoop falls over while student is climbing through*
Places ring toss rings on poll	Student will pick up ring toss rings off of the floor and place them on ring toss poll.	*Student throws ring toss rings* *Student places rings on head* *Student completes this step before completed prior steps in task analysis*	*Student picks up all rings at the same time and places them on poll* *Student drops ring on floor and does not attempt to pick it up within 5s* *Student misses poll and picks up ring and re-places it on poll*
Presses EASY button	Student approaches EASY button and presses down with one or both hands hard enough for the button to make audible "YES!" response.	*Student completes this step before completed prior steps in task analysis* *Student picks up/moves button* *Student does not press button hard enough for noise to be emitted*	*Student hits button and it falls to floor and the student does not attempt to pick it up within 5s*

Table 1. Operational definitions of obstacle course behaviors

Obstacle Course Task Analysis					
Student ID:					
Date:					
Baseline (BL) or Intervention (I)					
Session #					
# of times video model was played:					
Response (+/-/NR)					
Steps on balance stepping bucket #1					
Steps one foot on stepping bucket #2					
Places second foot on stepping bucket #2					
Steps one foot on stepping bucket #3					
Places second foot on stepping bucket #3					
Steps one foot on stepping bucket #4					
Places second foot on stepping bucket #4					
Steps one foot on stepping bucket #5					
Places second foot on stepping bucket #5					
Steps one foot on stepping bucket #6					
Places second foot on stepping bucket #6					
Steps down from stepping from last stepping bucket					
Hops with two feet onto carpet circle #1					

Table 2. Intervention task analysis.

Table 2 (cont'd)

Hops with two feet onto carpet circle #2					
Hops with two feet onto carpet circle #3					
Crawls through or climbs through (one foot at a time) hula hoop					
Stand up (if applicable)					
Pick up ring toss ring #1					
Place on pole					
Pick up ring toss ring #2					
Place on pole					
Pick up ring toss ring #3					
Place on pole					
Pick up ring toss ring #4					
Place on pole					
Approach Easy button					
Press Easy button until audible "Yes!" noise is produced					
Total duration:					
# of correct responses:					
# of total responses possible:					
Percentage of correct responses:					

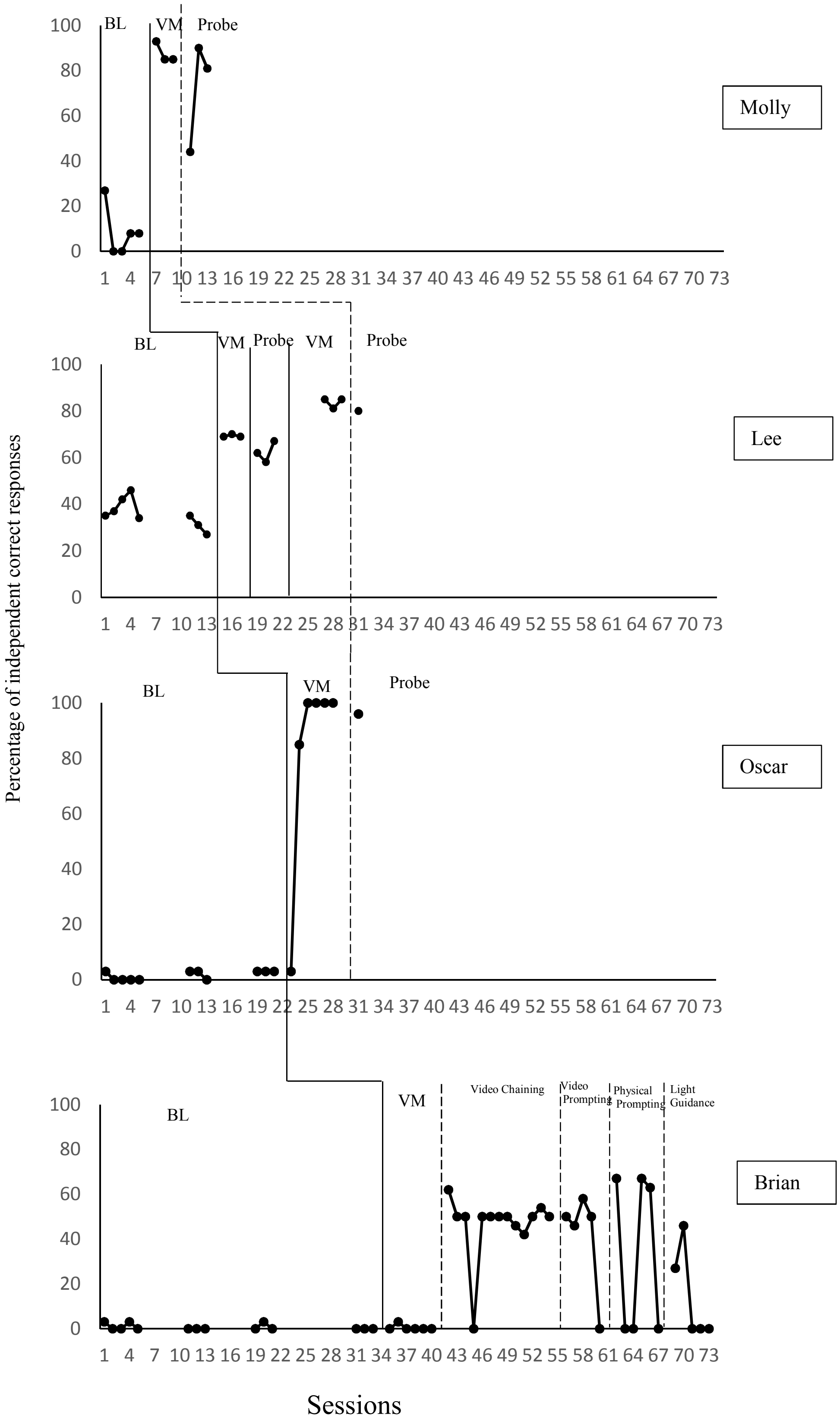

Figure 1. Percentage of independent correct responses for participants.

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