Article

Video Modeling and Test of Gross Motor Development-3 Performance among Children with Autism Spectrum Disorder

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Abstract: The purpose of this study was to explore the effects of video modeling on Test of Gross Motor Development-3 (TGMD-3) performance among children with autism spectrum disorder (ASD). Thirteen participants with ASD were assessed under two separate TGMD-3 protocol conditions—traditional and video modeling. Raters were blind to the protocol condition they were observing in order to prevent bias towards one condition. Total gross motor scores were analyzed using a one-way repeated-measures ANOVA. While improvements in overall gross motor scores with the video modeling condition were observed among children with ASD, differences were not statistically significant. Additionally, the video modeling condition took significantly longer time to complete than the traditional approach. The results do not provide support for the use of video modeling to improve TGMD-3 motor performance scores. Future research is necessary considering the promotion and use of video modeling is increasing.

Keywords: motor skills; motor assessment; visual support; TGMD

Introduction

Research claims that children with autism spectrum disorder (ASD) demonstrate motor skill deficits and delays (Lloyd, MacDonald, & Lord, 2011; Pan, Tsai, & Chu, 2009; Provost, Lopez, & Heimerl, 2007), with some studies suggesting these delays still exist after additional guidance or hand-over-hand manipulation (Berkeley, Zittel, Pitney, & Nichols, 2001; Staples & Reid, 2010). However, other studies have shown improved motor assessment performance scores with the inclusion of visual supports, such as picture task cards and picture activity schedules (Allen, Bredero, Van Damme, Ulrich, & Simons, 2017; Breslin & Rudisill, 2011; Liu & Breslin, 2013), that capitalize on the relative strengths that children with ASD have in processing visual information, as opposed to verbal information (Bryan & Gast, 2000; Tissot & Evans, 2003; Welton, Vakil, & Carasea, 2004). For example, Breslin and Rudisill (2011) found that incorporating picture task cards into the administration of the Test of Gross Motor Development-2 (TGMD-2) elicited significantly higher motor skill performance scores compared to the traditional method, which relied on verbal descriptions and physical demonstrations of the skills. Liu and Breslin (2013) similarly found that children with ASD scored higher on the Movement Assessment Battery for Children-2 (MABC-2) when provided with a picture activity schedule as opposed to the traditional assessment method. Additionally, a recent study demonstrated that a visual support protocol, in which picture cards are used in addition to the traditional administration of the TGMD-3, can significantly improve gross motor scores and is a valid and reliable method of measuring motor performance of children with ASD (Allen et al., 2017).

One additional visual approach that has recently received popularity as an evidence-based practice in general ASD research and practice is video modeling (Bellini & Akullian, 2007; Wong et al., 2015). The concept of modeling is grounded in the Social Learning Theory, which suggests that children may acquire or imitate skills by observing others perform the skills (Bandura, 1977). Video modeling is the video representation, as opposed to live demonstration, of a target skill or behavior modeled by another individual or one's self (Bellini & Akullian, 2007). This visual practice has been considered to be a more convenient and time-effective method to deliver instruction (Charlop-Christy, Le, & Freeman, 2000; Krause & Taliaferro, 2015), and potentially preferred to live formats among children with ASD (Cardon & Azuma, 2012). Additionally, because video modeling presents information visually, children with ASD may be able to interpret the instructions more clearly (Corbett & Abdullah, 2005; Tissot & Evans, 2003). This in turn prompts better understanding and may allow for a more accurate evaluation of the child's abilities and skill levels.

Although video modeling has received recent attention within ASD literature and practice, video modeling publications to date within motor skill research are limited and show inconsistent results. For example, Obrusnikova and Cavalier (2017) found that video modeling resulted in increased numbers of correctly performed standing long jump elements among children with intellectual disabilities. Robinson et al. (2015), however, found that a multimedia condition (i.e. condition using video and text) of the TGMD-3 among children without disabilities did not elicit significant differences in motor performance compared to the traditional condition. Despite these differing results, there has been a rise in interest in how video modeling can be used among children with ASD. At least 4 practical-based publications within the last 3 years have advocated for the use of video modeling in motor skill or physical education settings (Case & Yun, 2015; Colombo-Dougovito, 2015; Krause & Taliaferro, 2015; Obrusnikova & Rattigan, 2016). There is no doubt that video modeling is an interesting topic and appears to have great promise within motor skill settings. With limited and inconsistent research on this novel topic, however, it is necessary to establish more evidence that supports this increased use of video modeling as well as the contexts in which it can be beneficial.

Although recent evidence supports the inclusion of picture-based visual supports in gross motor assessment protocols among children with ASD, no literature to date has explored the use of video modeling in this area, despite rising interest and promotion of this practice in physical activity and physical education. Based on the suggested use of video modeling and technology in these settings (Bittner, Rigby, Silliman-French, Nichols, & Dillon, 2017; Krause & Taliaferro, 2015), it is important that empirical evidence exists that supports the use of video modeling and any positive associated effects such as improved skill performance and acquisition, administration time, and convenience among professionals. Thus, the primary purpose of this study was to examine the effects of video modeling on motor skill assessment performance among children with ASD. To address this purpose, this study explored two specific questions including the effects of video modeling on (1) movement skill performance and (2) total time required to complete the test, in comparison with the traditional methods of assessment. The secondary purpose of this study was to explore the effects of condition preference (traditional versus video modeling) among participants on motor skill performance.

Materials and Methods

Participants

Participants were recruited from advertisements through local elementary, middle and high schools, personal contacts of the investigators, and local campus-based community physical activity programs in the Northwest region of the United States. Children with ASD were included in this study if they were a) diagnosed with ASD as reported and confirmed by parents, b) able to hold and view videos on an Apple iPad, c) between the ages of 3 and 17, and d) physically able to perform the selected skills of the motor assessment. In order to confirm whether the child met the necessary inclusion criteria, the parent/guardian completed a brief demographic questionnaire regarding the child's diagnosis and abilities. Prior to each participant's inclusion in the study, informed consent and assent were collected for the parents and child, respectively. All study protocols, methods and materials were approved by the university's institutional review board.

A total of 14 children with ASD between the ages of 10 and 16 (mean age = 13.43 ± 1.83; boy = 14, girl = 0) participated in this study. One participant's data was excluded from data analysis because he did not appear to attend to the examiner's instructions and was not able to complete the assessment actions. The final number of children involved in the study was 13. Among the thirteen children with ASD, seven were diagnosed with autism and six were diagnosed with Asperger's disorder per parental report. Parents or guardians reported specific ASD diagnosis by a professional via a demographic questionnaire. Prior to data collection, all children and parents consented to participation of this study and the investigator's institution approved test procedures.

Instrument

The Test of Gross Motor Development-3 (Ulrich, in press) was administered in this study. The TGMD is one of the most popular motor development assessment tools in general and adapted physical education (Horvat, Block, & Kelly, 2007; Ulrich, 2000). The TGMD-3 has demonstrated excellent reliability and validity evidence across the TGMD-3 intended age groups of 3-10 years old (Webster & Ulrich, 2017). The age range of the present study's participants (3-17) was extended from the normative age range of the TGMD-3 (3-10) because the focus of this research was to examine the effect of video modeling rather than the validity of the included procedures. The TGMD has also been used within multiple previous studies with children, with and without ASD, who are older than the normative group (e.g. Henderson, Fuller, Noren, Mortensen Stout, & Williams, 2016; Issartel et al., 2017). Due to previous research suggesting that children with ASD display a lower level of motor development based on the TGMD-2 (Pan et al., 2009; Staples & Reid, 2010), a ceiling effect was not anticipated to be a problem. Additionally, Chun and colleagues (2002) provided strong validity evidence for the use of the TGMD-2 for children with intellectual disabilities between 11-18 years of age.

The TGMD-3 involves performance of six locomotor skills and seven ball skills with two trials for each skill included in the assessment (Ulrich, in press). Each motor skill is scored according to specified performance criteria on a dichotomous scale of 1 or 0. If the child performs the skill according to the criterion, the corresponding skill criterion receives a 1, whereas if the child does not perform the skill according to the criterion, the skill criterion receives a 0. The sums of the scores of the two trials for each skill are used to generate locomotor and ball subtest scores, which are then combined to determine an overall gross motor test score. The total possible scores a child can receive on the locomotor and ball subtest scores are 46 and 54, respectively, with a score of 100 as the highest possible gross motor test score. Because standardized gross motor test percentile scores were not yet available at the end of this study, the raw total gross motor scores were used to provide a representation of overall motor performance.

Experimental Condition Materials

For the video-modeling condition of the TGMD-3, all video footage was recorded by a digital video camera (JVC GZ-HM300 HD Everio Camcorder) and edited with iMovie (Apple, Inc.). Each skill included in the TGMD-3 was recorded from the perspective of a child watching the skill being performed. The primary investigator acted as the video model for all videos made. The selection of the primary investigator as the only adult model is based on literature that suggests models of all types have produced positive results (McCoy & Hermarisen, 2007; Shukla-Mehta, Miller, & Callahan, 2010), as well as feasibility and the investigator's ability to successfully demonstrate the tasks. Two experts on TGMD-3 motor development performance criteria observed the primary investigator's modeled performance and agreed the demonstrated skills were appropriate. The resulting videos were then edited and constructed into concise video demonstrations of each skill included in the TGMD-3. Each video consisted of 4 parts including (a) an appearance of the word(s) of the selected TGMD-3 skill, (b) a brief clip of the investigator providing the name and short description of the skill, (c) the video representation of the skill by the investigator, and (d) an appearance and voice overlay of the statement "Now you try!" (See Figure 1). The total duration of each video recording was approximately 17 seconds (mean = 17.08 seconds, range = 15 seconds – 22 seconds). An Apple iPad Air was used to deliver the video modeling presentations to the participants.

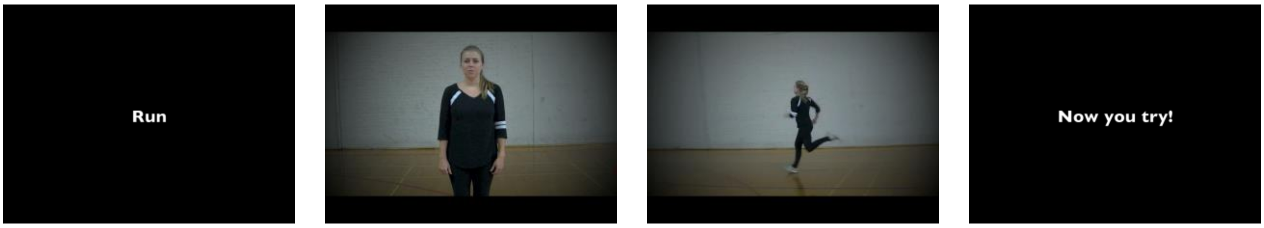

Figure 1— Example photo stills of a typical video shown to participants before specified TGMD-3 skill.

Procedure

The TGMD-3 was administered twice—once using the traditional protocol and once using the video modeling protocol—to each participant in a counterbalanced order on separate days. Depending on how each participant was recruited, the assessments took place at the child's school or the university campus. All participants recruited from their schools completed the assessments at their school during or immediately after school hours. The two tests were administered on separate days within approximately 7 days (median = 7 days, range = 5 days – 14 days, mean = 8.07 days, SD = 2.61) of each other at similar times of the day. The order of the tests was counterbalanced for each participant in order to reduce potential testing effects. All of the TGMD-3 assessments were video recorded in order for TGMD-3 performance and total assessment time to be coded later on. Total assessment time was defined as the total time of the assessment from the start of the administration to the completion of the final skill, and was measured by the length of each videotaped assessment (traditional and video modeling). The research assistant pressed "record" when the investigator began the TGMD-3 assessment procedure and pressed "stop" after the participant completed the second trial of the last TGMD-3 skill. Because both conditions were videotaped, assessment time was measured consistently across conditions and trials.

During the traditional TGMD-3 protocol condition, the test was presented to the participant using standardized assessment procedures described in the TGMD-3 Examiner Record Form (Ulrich, in press). The primary investigator gave verbal instructions and a physical demonstration of each skill. A second demonstration of the skill was given only if the child did not appear to understand the task or indicated that he or she needed to see the skill again. The same TGMD-3 assessment protocol was used for the video modeling condition, although video demonstrations were provided on the iPad as opposed to live demonstrations. The appropriate, corresponding video was shown to the participant via the iPad before he or she performed each skill. The same video was shown a second time only if the participant did not appear to understand the task or indicated that he or she needed to see the video again. All of the TGMD-3 assessments were video recorded in order for TGMD-3 performance and total assessment time to be coded later on. Immediately after the second assessment, the investigator asked each child which condition (live or video modeling) was preferred over the other. After the participant stated their preference, the investigator prompted the child to explain their choice by asking "Why did you like that one more?" Participants that indicated they did not prefer one condition to the other were also prompted to answer why. Responses for each preference option were tallied up after all data collection, and reasons why were written down by the investigator.

Data Reduction

Two research assistants were trained to evaluate the TGMD-3 performance criteria by watching video recorded TGMD-3 performances of children with and without disabilities. After each research assistant completed training with 12 practice videos over the span of 5 weeks, interrater reliability was tested. Raters who were in agreement higher than 80% prior to the start of data coding were included in this study. Interrater reliability was periodically tested throughout the study in order to minimize any drift. Interrater reliability ranged from 84% to 92% during the study.

Raters were also blind to the condition of the TGMD-3 performances they observed in order to prevent rater bias. Upon completion of each child's participation in the study, the investigator edited each child's two video recorded performances in a way that prevented raters from determining which condition was displayed. For example, each video clip started immediately before and ended directly after the skill was performed, and the investigator and iPad were never present in the videos. Because the video performances of each condition were edited to appear the same way, the research assistants did not have expectations as to which condition they were observing and did not experience bias towards one particular video. Additionally, each participant's two video recorded performances were presented to the raters in a randomized order.

Data Analysis

Two separate one-way repeated-measures ANOVAs were performed for total gross motor scores using the traditional and video modeling protocol conditions for children with ASD. Total test time of the traditional and video modeling conditions was also examined using a one-way repeated-measures ANOVA. Lastly, a 2x3 (condition by preference) repeated measures ANOVA was conducted in order to examine the effects of condition preference on gross motor scores. Effects of the testing conditions were tested at a significance level of 0.05. Additionally, participant responses for their preferred condition were tallied up to make comparisons between the two conditions. The reasons provided by the participants as to why they preferred one condition were categorized into common responses.

Results

The mean TGMD-3 total gross motor scores for the traditional (live) and video modeling conditions among children with ASD can be found in Table 1. Although the video modeling condition produced scores approximately 2 points higher than the live condition, the results of inferential statistics indicated no significant differences of total gross motor scores between the two conditions, $F(1, 12) = .90$, $p > .05$, $\eta^2 = .07$. A ceiling effect did not occur, as mean scores were below the 10-year age-equivalent and none of the participants obtained a perfect score.

Total assessment time in minutes for the traditional and video modeling conditions were respectively 15.89 ± 4.04 and 18.92 ± 5.13. Results of the repeated-measures ANOVA revealed significant differences, $F(1, 12) = 15.87$, $p < .01$, $\eta^2 = .57$. These findings suggest that it takes significantly longer time to complete the video modeling condition of the TGMD-3 than the traditional protocol for children with ASD. Table 1 summarizes the total gross motor scores, total assessment time, and standard deviations across TGMD-3 conditions.

Table 1. Means and standard deviations of total gross motor scores and assessment time by TGMD-3 condition

	TGMD-3 Condition			
	Live		Video Modeling	
Variable	Mean	SD	Mean	SD
Total Scores	70.46	18.81	72.00	17.68
Time	15.89*	4.04	18.92*	5.13

Note. Time measured in minutes; Significance of p< .01 indicated by *

Descriptive statistics of participant preferences indicate an equal amount of participants (n=5) preferred one condition to the other, while three participants had no preference or did not respond. Considering the effect of condition preference on gross motor scores, although TGMD-3 raw mean scores were higher during the preferred condition for children with ASD, condition preference was not found to produce significant differences in total gross motor scores between conditions, $F(2, 10) = 1.81$, $p > .05$, $\eta^2 = .27$. Descriptions of gross motor scores by condition preference can be found in Table 2. Participants who preferred the traditional condition of the TGMD-3 provided reasons such as quicker timing and already being familiar with the skills in the video. Those who preferred the video modeling condition gave explanations relating to their love for video and technology, visual format, and the ability to work independently.

Table 2. Descriptions of gross motor scores given by condition preference

		TGMD-3 Scores by Condition			
		Live		Video Modeling	
Preference	n	Mean	SD	Mean	SD
Live	5	80.40	6.39	79.60	9.21
VM	5	70.80	7.53	71.60	11.37
Other	3	53.33	35.22	60.00	32.97

Note. Preference = Protocol condition preferred by participants of each group; VM = Video Modeling

Discussion

The main purpose of this study was to compare the effects of video modeling on TGMD-3 performance for children with ASD to the traditional protocol. Although slight improvements in raw scores were observed, the differences in TGMD-3 scores were not statistically significant. Therefore, the findings of the present study do not support our hypothesis that total gross motor scores would be greater following the video modeling condition of the TGMD-3. This nonsignificant finding is consistent with results of a recent, similar video modeling study, which also found that motor assessment scores did not significantly improve when participants (n=10, ages 5-12 years) were shown the video modeling condition, as well as a picture-based condition (Colombo-Dougovito, 2017).

Video modeling may have produced nonsignificant results for a number of reasons. First, it is possible that the present study's specific video modeling strategies were not effective and/or did not provide participants with ASD with enough information. While past studies' recommendations were used in the creation of the present study's video modeling procedures (Bellini & Akullian, 2007; Ganz, Earles-Vollrath, & Cook, 2011; McCoy & Hermarisen, 2007; Shukla-Mehta et al., 2010; Wilson, 2013), small differences within duration of videos, overall presentation, and/or the general research field may have caused video modeling to be less effective within motor assessment settings. For example, previous studies have suggested video clip lengths of 3-5 minutes and multiple viewings and/or sessions for social, behavioral, communicative and play skills (Bellini & Akullian, 2007; Shukla-Mehta et al., 2010), with effective interventions using videos as short as 30 seconds (Bellini & Akullian, 2007). However, the present study's videos were approximately 17 seconds on average, and were shown to the participants a maximum of two times as specified in the TGMD-3 Examiner Record Form (Ulrich, in press). Past research (e.g. Cardon & Azuma, 2012) that has indicated children with ASD visually attend to video presentations significantly longer than live presentations used videos 107 seconds in length—approximately 90 seconds longer than the present study's videos—suggesting short videos may not be long enough to interest children with ASD and/or provide them with adequate information. It is also possible that video modeling was not appropriate for the participants within this sample. Previous literature has indicated that evaluating visual processing and comprehension skills may be necessary in order to determine the type of content included in video modeling strategies (Shukla-Mehta et al., 2010), and that individual assessment may be helpful when considering the effectiveness of interventions with particular students (Dowrick, 1991).

Additionally, to the best of the author's knowledge, this study is the first study in which raters were blind to the conditions utilized for each motor performance. Two research assistants were blind to the condition of each TGMD-3 performance and therefore had no bias towards one condition while coding performances. Previous studies involving video modeling and/or other visual supports within physical activity or motor development settings have not included blind coders (Allen et al., 2017; Breslin & Rudisill, 2011; Cannella-Malone, Mizrachi, Sabielny, & Jimenez, 2013; Liu & Breslin, 2013), and therefore may not have been able to fully eliminate bias towards the experimental condition. Resultantly, it is difficult to draw conclusions about the overall effectiveness of video modeling versus the quality of specific video modeling or visual support procedures. Regardless of reasoning, it is vital that video modeling is portrayed accurately within gross motor skill and assessment literature, whether effective or ineffective, so that involved professionals are able to make informed decisions (e.g. time, cost, potential advantages or disadvantages). Future research utilizing video modeling within motor assessments should therefore consider blinding raters to the present condition used with each motor performance in order to confirm accurate, unbiased representations of the effectiveness of video modeling and other visual support strategies.

This study also examined the effectiveness of video modeling on total TGMD-3 assessment time compared to the traditional protocol. The video modeling condition of the TGMD-3 lasted statistically significantly longer (2-3 minutes) than the traditional protocol. Due to interests in viewing videos among children with ASD (Nally, Houlton, & Ralph, 2000), it is possible that participants were more interested in watching the videos, and therefore asked to watch the video one more time, thus extending the total assessment time. Frequency of video replays and additional live demonstrations were not accounted for across participants, however, so making this conclusion is challenging. It is also possible that the process of picking up and accessing the iPad, finding the correct video file, and clicking play to show the participant could have added time to the overall assessment duration. Regardless of reasoning, these findings contradict past recommendations in support of video modeling strategies as a result of increased time-efficiency (Bellini & Akullian, 2007; Charlop-Christy et al., 2000). Although a 3-minute difference may not seem like a large amount of time, that extra amount of time may be enough to contradict a child's individual attention and tolerance levels and/or the professional's availability. Future assessment research may benefit from focusing on total assessment time and the associated implications it may have on participant and examiner characteristics.

The second purpose of this study was to examine the effects of condition preferences on total gross motor scores for children with ASD. Conditions were equally preferred (live = 5, video modeling = 5, no preference = 3) among children with ASD. Although participant mean scores were higher on the condition they preferred, differences in total motor scores between conditions according to preference were not found to be statistically significant.

Participants with ASD gave a variety of reasoning for their preferences. Reasons given by participants with ASD as to why they preferred live demonstrations to video modeling included "I love technology and iPads, but I would rather do *this* without the iPad," and "I liked it better because it was quicker." One participant even explained that he knew he understood information better when presented through technology but "the skills were too easy" and he "already knew how to do them." Despite this participant's comment, however, none of the participants obtained a perfect score on either of the subscales, indicating that there was no ceiling effect. He noted that if the skills were harder and new to him, he would have preferred to learn them from the iPad, which may provide insight into using video modeling strategies for teaching motor skills Participants who preferred the video modeling condition to the traditional protocol provided reasons such as love for and interest in technology and increased clarity due to the "visual" given from the iPad. One participant also explained that he preferred working with the iPad because he did not have to "bother" anyone else and was able to avoid others by working independently. This response aligns with previous hypotheses that preferences for video modeling among children with ASD may be related to their differences in social communication and avoidance of eye contact (Charlop-Christy et al., 2000). These results were not found to be statistically significant and therefore cannot be extended to all children with ASD. However, the observed increases in raw total gross motor performance scores according to child preference may offer insight to future studies assessing condition preference, as well as support the notion that the effectiveness of video modeling strategies may be individual (Dowrick, 1991; Shukla-Mehta et al., 2010) and influenced by other variables such as participant characteristics, functioning, and preference.

There are certain limitations within this study that must be addressed. ASD severity, communication and visual processing skills of participants were not assessed in this study. It is possible that video modeling may be more effective for children with different levels of functioning than others (Dowrick, 1991; Shukla-Mehta et al., 2010). Due to the wide range of individuals in this sample, this information could have been useful to compare outcomes across different severities and levels of functioning. Additionally, this study's sample of children with ASD was small (n = 13), all male, and did not include young children (ages 3-10). It is therefore difficult to expand these findings to other samples within this population, and readers should use caution in generalizing these results to all other children with ASD. We are also unclear of the effect that age may have on other factors such as familiarity with technology, comprehension of video modeling, and assessment performance. We recommend that future studies account for or investigate this potential variation. Future research within video modeling and motor skill performance should also aim to include a larger, more diverse sample size as well as collect data regarding the specific functioning of participants in order to gain more insight on the effectiveness of video modeling among multiple populations.

Perspectives

In summary, the effect of video modeling on motor skill assessment performance for children with ASD remains inconclusive. Although there is a variety of literature that provides evidence-based recommendations for creating video modeling interventions in academic, social and behavioral fields of research (Bellini & Akullian, 2007; Ganz et al., 2011; Shukla-Mehta et al., 2010; Wilson, 2013), and recent suggestion-based papers suggest for the use of video modeling in physical education and assessment (Case & Yun, 2015; Obrusnikova & Rattigan, 2016), there are currently no studies that empirically support the use of video modeling strategies to improve motor skills among children with ASD. It is therefore the recommendation of these authors that present and future studies examining video modeling within motor assessment and physical education are offered in the literature, regardless of the outcome, with detailed accounts of the included methodology. With interest in this area rising, it may be useful for researchers to be aware of other video modeling designs and procedures in order to compare and use for reference. It will also be important for practitioners to make educated decisions about the visual strategies they implement within their classrooms and assessments.

With substantial interest in this area, it is important that research continues to examine the effects of video modeling among diverse samples and ages of ASD. Especially with its indication as an evidence-based practice among children with ASD, video modeling may be a great addition to adapted physical activity research and practice. Lastly, although current literature does not conclusively support the use of video modeling to increase gross motor assessment scores, some studies have provided evidence for video modeling to improve gross motor skills overtime among children with ASD (Cannella-Malone et al., 2013; Yanardag, Akmanoglu, & Yilmaz, 2013). Future video modeling research also may benefit from directing efforts towards intervention and teaching gross motor skills as opposed to evaluating skills.

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