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The Effect of Visual Supports on Performance of the TGMD-2 for Children With Autism Spectrum Disorder

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The purpose of this study was to examine the effects of visual supports on the performance of the Test of Gross Motor Development (TGMD-2) for children with autism spectrum disorder (ASD). Participants (N = 22) performed the TGMD-2 under three different protocols (traditional protocol, picture task card protocol, and picture activity schedule protocol). Gross motor quotient scores on the TGMD-2 were measured and statistically analyzed using a within-subjects repeated-measures ANOVA. Results indicated statistically significant differences between protocols, while post hoc tests indicated that the picture task card condition produced significantly higher gross motor quotient scores than the traditional protocol and the picture activity schedule. The results suggest that more accurate gross motor quotient scores on the TGMD-2 by children with ASD can be elicited using the picture task card protocol.

Keywords: fundamental motor skills, picture task cards, picture activity schedule

Many children with disabilities, including those with autism spectrum disorders (ASD), are at-risk of not learning the fundamental motor skills. ASDs are the fastest growing developmental disability in the United States today (Centers for Disease Control and Prevention, 2010). ASDs include autistic disorder, Asperger's disorder, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS). These disorders are related by various behavioral characteristics, including difficulty and deficits in communication and social interaction and the exhibition of repetitive and restrictive stereotypic behaviors (American Psychiatric Association [APA], 2000). Individuals with ASD also exhibit a relative strength in processing visual information but have difficulty in processing and interpreting auditory information (Grandin, 1995; National Research Council, 2001; Tissot & Evans, 2003). These diagnostic criteria, in conjunction with the differences in information processing, may influence the development of fundamental motor skills in children with ASD. To avoid delays in skill development, practitioners should implement an effective instructional approach for teaching fundamental motor skills to these children.

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Recent research has suggested that children with ASD exhibit delays in their motor skill development (Baranek, Parham, & Bodfish, 2005; Berkeley, Zittel, Pitney, & Nichols, 2001; Jansiewicz et al., 2006; Minshew, Sung, Jones, & Furman, 2004; Pan, Tsai, & Chu, 2009; Provost, Lopez, & Heimerl, 2007; Rinehart, Bradshaw, Brereton, & Tonge, 2001; Staples & Reid, 2010); however, earlier research examining motor skill development of children with ASD yielded inconsistent results (DeMyer et al., 1972; Klin, Volkmar, & Sparrow, 1992; Morin & Reid, 1985; Stone, Ousley, & Littleford, 1997; Stone, Ousley, Hepburn, Hogan, & Brown, 1999). It is possible that these findings may have been influenced by the assessment protocols used to measure motor skill development. Specifically, many of the assessments were designed for use with typically developing populations, yet they have been implemented in studies examining children with ASD. Only one of the assessments implemented in these studies, the Vineland Adapted Behavior Scales, was validated for use with children with ASD, and only one study took precautions to ensure that the participants understood the assessments used to measure motor skill development (Staples & Reid, 2010). Although the Vineland Adapted Behavior Scales has high reliability and validity in measuring social functionality among children with disabilities (Sparrow, Balla, & Cicchetti, 1984), it is not a process-based assessment of motor performance as compared with the widely used Test of Gross Motor Development (Second Edition, TGMD-2; Ulrich, 2000). A process-based assessment measures performance as a function of characteristics describing the quality of movement, as opposed to a product approach that measures performance on outcome variables such as distance or time (Burton & Miller, 1998).

Studies utilizing the TGMD found that fundamental motor skill development is delayed in children with ASD (Berkeley et al., 2001; Pan et al., 2009; Staples & Reid, 2010); however, two of these research teams mentioned that methodological issues arose when assessing motor skills with this population (Berkeley et al., 2001; Staples & Reid, 2010). Consequently, the TGMD performance results may have been compromised. One of these studies reported that when performing the locomotor skills, the participants would move from one place in the assessment environment to another without attempting to perform the locomotor skills (Berkeley et al., 2001). The results of that study led to the conclusion that children with ASD exhibit poor performance on fundamental motor skills. Specifically, when the participants were asked to run, gallop, or skip for the assessment, they exhibited walking or running behavior. After observing the throw, one participant walked the ball to the target and dropped it (Berkeley et al., 2001). It appears that the researchers did not account for the communication difficulties experienced by children with ASD by presenting the information in a visual rather than auditory modality. It is possible that the children did not understand the instructions presented in an auditory fashion. Another study utilizing the TGMD-2 to examine motor skillfulness in children with ASD reported that participants did not seem to understand how to perform the skills correctly (e.g., participants did not understand the difference between rolling and throwing a ball) and suggested providing individualized instruction to each participant being assessed (Staples & Reid, 2010). In this study, the researchers provided individualized instruction and hand-over-hand guidance, while the participants performed a practice trial of the skill.

Given the increasing prevalence of ASD, it is important that physical educators and researchers adapt instructional and assessment techniques to accommodate the

needs of students with ASD to derive the student's true performance. These adaptations may influence students' motor skill development during physical education because effective instructional programming for students with ASD assumes that each child's performance has been accurately assessed. Due to the difficulties and deficits in communication and social interaction demonstrated by children with ASD, the verbal approach used by most practitioners and researchers to provide instruction while assessing motor skills may not be appropriate due to problems children with ASD have with information processing. When performing motor skills, there are stimuli that should be attended to and processed and other stimuli that should be ignored (Norman, 1968). Due to the sensory processing difficulties, many individuals with ASD struggle to recognize and identify stimuli appropriately (Belmonte et al., 2004; Broun, 2004; Minshew & Goldstein, 1998). Therefore, when working with children with ASD, teachers or assessment administrators should consider modifying the environment to help children with ASD attend to, recognize, and respond to the most important stimuli of the task.

Visual supports, such as picture task cards and picture activity schedules, may provide a means to increase the validity of motor skill assessments by providing information in a preferred modality. Visual supports help direct attention to the relevant stimuli within the task, display the abstract constructs of the task in concrete ways, and organize the environment surrounding the student with ASD, thereby reducing confusion regarding the surrounding environment and how to organize and process information (Andrews, Decker, & Boswell, 1998; Bryan & Gast, 2000; Collier & Reid, 1987; Dooley, Wilczenski, & Torem, 2001; Fittipaldi-Wert, 2007; Johnston et al., 2003; MacDuff, Krantz, & McClannahan, 1993; National Research Council, 2001; Reid, Collier, & Cauchon, 1991; Schneider & Goldstein, 2010; Schultheis, Boswell, & Decker, 2000; Welton, Vakil, & Carasea, 2004).

Visual supports may include, but are not limited to, picture cards and activity schedules (National Research Council, 2001; Odom et al., 2003; Rao & Gagie, 2006). A picture card is a pictorial representation of a person, place, thing, or action that an individual may provide to another individual to exchange information when verbal communication is difficult (Welton et al., 2004). Picture cards have been found to be successful in increasing on-task behaviors and decreasing disruptive, off-task behaviors (Dooley et al., 2001; Johnston et al., 2003). Activity schedules are visual depictions of the sequence of behaviors and activities in which the student is to engage to complete the desired task (Bryan & Gast, 2000; Welton et al., 2004). Visual activity schedules are designed to decrease contextually inappropriate behaviors and increase time on-task of the individual with ASD by providing order and predictability to the environment and alleviating anxiety about "what comes next?" in the day (Downing & Peckham-Hardin, 2000; Welton et al., 2004). Picture activity schedules have been found effective in decreasing self-injurious behavior (O'Reilly, Sigafoos, Lancioni, Edrisinha, & Andrews, 2005), decreasing aggression and increasing cooperation in classroom settings (Dooley et al., 2001), increasing on-task behaviors and decreasing off-task behaviors in language arts activities (Bryan & Gast, 2000), and teaching new leisure skills (MacDuff et al., 1993). Picture activity schedules provide more information than a picture task card as they also visually present information regarding the order in which activities should be completed (Kimball, Kinney, Taylor, & Stromer, 2004).

A widely used assessment of fundamental motor skills in the United States is the TGMD-2 (Ulrich, 2000). Although two physical demonstrations are permitted, the instructions for each item are to be presented through a series of verbal commands explained in the *TGMD-2 Examiner's Manual*. The auditory instruction may be difficult for children with ASD to understand; as such, their performance could be affected. Therefore, the purpose of this study was to examine the effectiveness of visual supports (i.e., picture task cards and a picture activity schedule) on the gross motor quotient performance on the TGMD-2 by children with ASD. It was hypothesized that TGMD-2 gross motor quotient performance for children with ASD would be significantly higher when the assessment protocol incorporated the picture activity schedule condition than the incorporation of the picture task card condition and the traditional protocol. Because individuals with ASD experience difficulties processing verbal instructions and understanding the concept of time, the picture activity schedule was hypothesized to elicit better performance on the TGMD-2 as compared with performance using the traditional assessment protocol. This hypothesis was based on the notion that a picture activity schedule assists the child in understanding what comes next in the schedule of activities for the day (Downing & Peckham-Hardin, 2000; Welton et al., 2004). Furthermore, the visual depiction of the activities to be completed in the TGMD-2 should aid in minimizing the amount of verbal instruction required. It was also hypothesized that the picture task card condition would elicit higher gross motor quotient scores on the TGMD-2 by children with ASD than the traditional protocol.

Method

Participants

Data collection was conducted during a summer supplemental educational program, serving as extended year services for students with ASD and behavioral disorders, located in a small city in the southeastern United States. The summer program enrolled 42 students, all of whom lived at home and 85% of whom had ASD. The primary investigator administered the TMGD-2 administrator during the study and had over one year of experience working as the physical education teacher at a university affiliated preschool program for children with ASD.

Participants were selected because parent report data indicated they met the inclusion criteria for ASD according to the Diagnostic and Statistical Manual (Fourth Edition, Text Revision; APA, 2000) as assessed by a developmental pediatrician or a trained, licensed psychologist. In addition, participants were considered for inclusion in the study if they met the age requirements for the TGMD-2 as of the time of data collection. Participants were excluded from data collection if the parent report data indicated the child had a concomitant diagnosis besides an ASD. Upon institutional review board approval and the return of parental informed consent forms, 30 participants were recruited. Four of the participants recruited were older than 10 years of age and were therefore excluded from participation due to the age range within the TGMD-2 norms, and four participants were excluded from data analysis due to incomplete data sets, yielding a sample of $n = 22$ (male = 16, female = 6, African American = 5, Caucasian = 17, age range = 3.5 years—10.92

years). Sixteen of the participants were diagnosed with autistic disorder, four were diagnosed with PDD-NOS, and one child was diagnosed with Asperger's disorder. One additional participant was diagnosed with autistic disorder and PDD-NOS.

Instrument. The TGMD-2 was used to assess the fundamental motor skills of children with ASD. This assessment examines locomotor skills of running, galloping, hopping, jumping, leaping, and sliding and the object control skills of striking a stationary ball, stationary dribbling, catching, kicking, overarm throwing, and underhand rolling (Ulrich, 2000). The scores are derived from age- and sex- based norms of 3–5 performance criteria for each skill. For each criterion, a child was scored with either a 1 or a 0, indicating that the child performed or did not perform the specific criterion correctly for each skill. The sum of these scores was used to determine a subtest standard score adjusted for age and sex for both locomotor and object control skills, ranging from 1 to 20, as specified in the *TGMD-2 Examiner's Manual*. Both standard scores were then summed. This sum was compared with a table in the *TGMD-2 Examiner's Manual* to determine the gross motor quotient score, ranging from 46 to 160, as per the instructions in the *TGMD-2 Examiner's Manual* (Ulrich, 2000).

The primary investigator and a research assistant blind to the purpose of the study were trained to evaluate the criteria of test performance as mandated in the *TGMD-2 Examiner's Manual*. This was accomplished by using videotaped data of typically developing children performing TGMD-2 assessments. This training continued until the data coders met 90% agreement on two consecutive days. The primary investigator and the research assistant then coded videotape data of each child's performance on every item for each protocol of the test to ensure the primary investigator's codes were not influenced by expectancy bias. The research assistant had no prior experience interacting or observing children with ASD. As such, the research assistant did not know what to expect behaviorally from the participants or instructionally from the TGMD-2 assessment administrator while observing the videotapes. Aggregate interrater reliability for TGMD-2 criterion coding was calculated at 95.74%.

Procedure

Each participant experienced a 20 min acclimation period in the testing environment (arranged as it would be during an actual assessment) on the day immediately preceding the first day of TGMD-2 data collection. All data collectors were present during the acclimation period, and the participants were familiarized with the assessment environment and the assessment procedure.

To collect data, the TGMD-2 was administered three times using the different protocols by the primary investigator. On three consecutive school days, each child was asked to complete the TGMD-2 under one of the three protocol conditions. The order of the conditions were counterbalanced and randomly assigned to ensure that learning did not influence the results. Data collection was conducted in the same multipurpose room of the elementary school in which the supplemental summer educational program was held. All TGMD-2 assessments were videotaped, including the acclimation period.

During the traditional protocol condition, the protocol from the *TGMD-2 Examiner's Manual* was explicitly followed. The test was presented using verbal instructions in complete sentences, a demonstration of the assessment item, and a second demonstration if the child indicated through behavior or verbal request that he or she did not understand the item. In the picture task card condition, verbal instructions were minimized by the use of two or three word commands such as "jump over beanbag," "run fast," "throw hard." Although a demonstration for each assessment item was still provided, additionally one small laminated card (6 cm × 6 cm) with a line drawing depicting the assessment item was shown to the child in conjunction with the short verbal instructional command immediately preceding the physical demonstration of the skill. Figure 1 is a photograph of the twelve laminated cards used in this study. That picture card was also displayed to the child again if a second demonstration was required and in between the two trials comprising each item on the TGMD-2. In the picture activity schedule condition, verbal instructions were minimized in the same way as in the picture task card condition, and line drawings depicting motor skill activities were presented to the children; however, in this condition, the line drawings were presented in order and affixed vertically on a poster. Each line drawing was removed from the poster before the performance of each motor skill on the TGMD-2. Once a drawing was removed from the schedule board, it was displayed to the participant before each motor skill trial in the same manner as during the picture task card condition.

Results

A repeated-measures ANOVA was conducted with protocol condition as the grouping variable and performance on the TGMD-2 as measured by gross motor quotient as the repeated measure. The main effect for protocol condition was statistically significant, $F(2,42) = 6.66$, $\eta^2 = 0.24$, $p = 0.003$. These findings show that the TGMD-2 administrative protocol conditions produced significantly different performances in gross motor quotient scores. The means and standard deviations for the TGMD-2 gross motor quotient performance by protocol condition (i.e., traditional protocol, picture task card, and picture activity schedule) were 63.05 ± 15.94, 68.91 ± 18.30, 67.14 ± 17.46, respectively. The Bonferroni follow-up test indicated that gross motor quotient was significantly higher ($p = 0.008$) using the picture task card protocol than the traditional protocol. All statistical assumptions were met for these analyses.

Since a main effect for protocol treatment condition was found for the TGMD-2 gross motor quotient scores, a repeated-measures MANOVA was conducted to assess differences on the individual items of the TGMD-2. All statistical assumptions were met for this analysis, but the results of the MANOVA were not statistically significant, $F(24,58) = 0.82$, $\eta^2 = 0.25$, $p = 0.707$. Therefore, the increased gross motor quotient scores in the picture task card condition cannot be attributed to improvement in any particular motor skill on the TGMD-2. Table 1 depicts the raw score means and standard deviations for individual items on the TGMD-2.

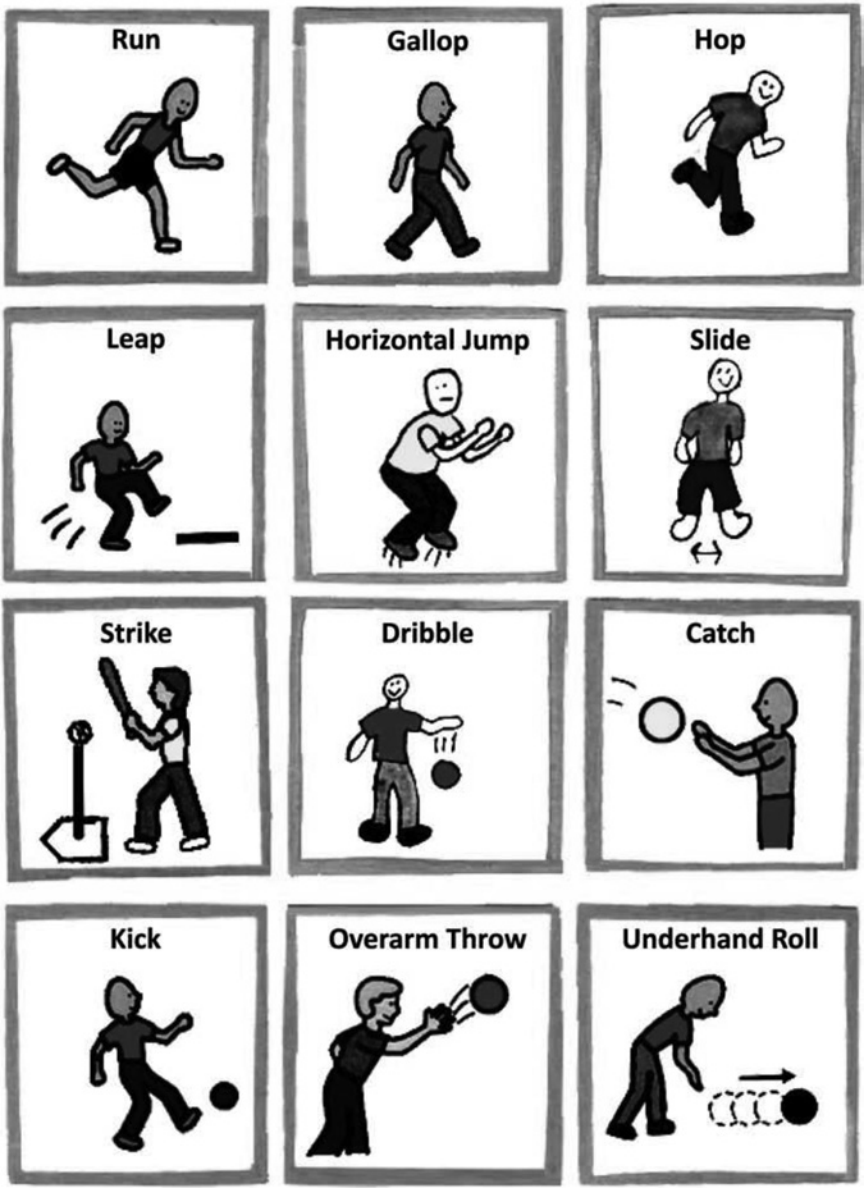

Figure 1 — Picture task cards used in the picture task card condition.

Table 1 Means and Standard Deviations for the Individual Items on the TGMD-2 for Each Protocol

	Traditional Protocol		Picture Task Card Condition		Picture Activity Schedule Condition	
Skill	**M**	**SD**	**M**	**SD**	**M**	**SD**
Run	5.05	2.40	5.38	2.77	5.14	2.97
Gallop	2.81	3.31	2.90	3.27	3.10	3.35
Hop	1.95	2.97	2.14	3.26	2.71	3.68
Leap	1.52	1.91	1.90	2.28	1.86	2.08
Jump	2.57	2.80	2.76	2.55	2.29	2.95
Slide	2.24	3.08	2.57	3.23	3.00	3.47
Strike	4.29	1.93	4.86	2.20	4.81	1.99
Dribble	2.29	3.24	2.90	3.22	2.29	3.33
Catch	2.19	2.09	2.57	2.48	2.14	2.08
Kick	4.81	1.75	4.71	2.49	4.81	2.11
Overarm Throw	1.86	2.50	2.33	2.61	2.19	2.42
Underhand Roll	2.76	2.72	3.19	2.79	2.90	2.39

Discussion

The purpose of this study was to empirically examine the influence of visual supports on the performance of children with ASD on the TGMD-2. The results partially supported the hypothesis. Specifically, the picture task card condition elicited significantly higher gross motor quotient scores than the traditional protocol, but the picture activity schedule condition did not elicit higher gross motor quotient scores compared with the other two conditions. It may be that the picture activity schedule is an unnecessary organizational tool that actually provides too much information to the child during individual assessment situations. The picture activity schedule used displayed a greater number of items (12) to be completed in a shorter duration of time (30 min) than in previous studies. In previous studies, the picture activity schedules were limited to 10 activities that were used to guide the student throughout the entire school day (Dooley et al., 2001) or the schedule depicted fewer activities in a shorter duration of leisure time or class time (Bryan & Gast, 2000; Fittipaldi-Wert, 2007; MacDuff et al., 1993). Furthermore, these studies had more than one child (without a disability or another child with ASD) present in the room while the picture activity schedule was in use (Dooley et al., 2001; Fittipaldi-Wert, 2007; MacDuff et al., 1993), whereas children were assessed individually in the current study.

Although the picture activity schedule was not found to elicit statistically significantly different results than the traditional protocol, the results indicate that utilizing picture task cards and minimizing verbal instruction while administering the TGMD-2 may result in higher gross motor quotient scores on the TGMD-2. The minimization of verbal instruction and the use of pictures to convey information have been widely accepted by special education teachers (Downing & Peckham-Hardin, 2000; Mesibov, 2006; National Research Council, 2001; Rao & Gagie, 2006; Schultheis et al., 2000; Simpson, 2005; Tissot & Evans, 2003), and this study provides evidence to support this practice in assessment settings.

In both the picture activity schedule and picture task card conditions, the researcher used short commands to limit the amount of auditory information that must be processed to complete the TGMD-2. A visual support was presented in addition to the physical demonstration to capitalize on the child with ASD's strength in visual processing and minimize the impact of their difficulty processing auditory information (Grandin, 1995; Simpson, 2005). With respect to the mean gross motor quotient scores for each protocol, there was less than a two-point difference between the two visual supports conditions and a nearly six-point difference between the picture task card condition and the traditional protocol. Given the range of gross motor quotient scores (46–103) obtained by participants across all three protocols, a nearly six-point difference in scores equates to 10% change in performance. This finding has practical implications for teachers measuring student performance. It should be noted that as individuals with ASD can exhibit a range of severity (Coplan, 2003), and not every individual with ASD will respond to the assessment protocol in the same way. Therefore, future studies might need to examine differences in assessment performance on an individual level to account for these differences as group designs may not illustrate individual changes in performance (Bouffard, 1993).

The results indicate that regardless of the protocol used, children with ASD are developmentally delayed in terms of their performance of fundamental motor skills included on the TGMD-2. Thirteen of the 22 participants would qualify to receive adapted physical education services according to the criteria set by the American Association for Physical Activity and Recreation (AAPAR) and the National Association of Sport and Physical Education (NASPE). This criteria indicates that if a child scores at or below the 7th percentile for his or her age or if a child's score is more than 1.5 deviations below the mean for a normative based assessment, that child qualifies for adapted physical education standards regardless of the child's behavioral characteristics (AAPAR & NASPE, 2010). This finding further supports the body of literature indicating that children with ASD are delayed in terms of their motor skill development (Baranek et al., 2005; Jansiewicz et al., 2006; Minshew et al., 2004; Morin & Reid, 1985; Provost et al., 2007; Rinehart et al., 2001; Stone et al., 1997) and replicates the findings that children with ASD are delayed in terms of their fundamental motor skill development as measured by the TGMD (Berkeley et al., 2001; Pan et al., 2009; Staples & Reid, 2010).

In spite of these findings, certain limitations must be addressed. One limitation is that the design of this experiment did not investigate how many of the differences in the TGMD-2 performance can be attributed to the visual supports that were used as compared with the minimization of the verbal instruction. Future studies should seek to compare performance on the TGMD-2 when picture task cards are

used in conjunction with the verbal instructions in conversational sentences as instructed in the *TGMD-2 Examiner's Manual* versus picture task cards with concise commands. In addition, the researchers did not collect data regarding the participants' medication consumption. Certain medications, including the antipsychotic medications commonly prescribed to individuals with ASD, may have influenced their motor skill performance. If children were taking medication, however, that influence should have been consistent across all conditions in the current study. Another limitation is that cognitive or communicative functioning of the participants was not assessed. It is possible that the level of cognitive or communicative functioning of the participants may explain the differences in performance on the TGMD-2. Future researchers working with children with ASD should collect data regarding cognitive functioning or communication skills so as to better explain which populations might benefit from their research. Finally, this study should be replicated with more participants and a smaller age range. This replication may help to determine if the traditional protocol condition is actually no different than the picture activity schedule condition or if the present findings regarding these conditions can be attributed to low statistical power.

In summary, the findings from this study show that children with ASD are developmentally delayed in their motor skill development. The results also show that picture task cards may provide a more effective way to communicate instructions to children with ASD resulting in a more valid test score interpretation. It appears that informing the child with ASD about the task to be completed and directing attention to relevant stimuli in the surrounding environment can positively impact performance on motor skills assessments. Incorporating picture task cards into the TGMD-2 protocol elicited higher gross motor quotient scores compared with the traditional protocol. Because children with ASD benefit from the use of the picture task cards, it is recommended that the authors of the TGMD-2 include picture task cards as part of the *TGMD-2 Examiner's Manual* for use by assessment administrators working with children with ASD.

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